OSCILLOQUARTZ
SWATCH GROUP ELECTRONIC SYSTEMS

OSA 5565
Synchronization Test Set

With WinSTS V3.0x

USER MANUAL

This page has been intentionally left blank

What's new in this revision

- Creation

This page has been intentionally left blank

Table of Contents Page

1 INTRODUCTION 1-1

1.1 About this Manual 1-3

1.2 Reading Guide 1-4

1.3 Safety Instructions 1-5

1.4 Warranty 1-8

1.5 Certification 1-9

2 GENERAL DESCRIPTION 2-1

2.1 Overview 2-3

3 SPECIFICATIONS 3-1

3.1 Input Line IN 3-3

3.2 Input AUX 3-5

3.3 Input EXT.REF 3-5

3.4 Output REF OUT 3-6

3.5 Outputs OUT 1, OUT 2 3-6

3.6 Phase Measurement Unit 3-7

3.7 Internal Reference Oscillator 3-7

3.8 Mechanical 3-8

3.9 Environmental 3-8

3.10 Power Supply 3-8

3.11 Connector Pin-Out 3-10

4 INSTALLATION & TURN-ON PROCEDURE 4-1

4.1 Required Hardware Configuration 4-3

4.2 Software Installation 4-3

4.3 Selection of the Printer Type 4-3

4.4 Connections 4-4

4.5 Turn-On Procedure 4-6

4.6 Starting up the WinSTS Program 4-6

5 MODULES DESCRIPTION 5-1

5.1 IIU-10/M Input Interface Module 5-3
5.2 IIU-6/M Input Interface Module 5-4
5.3 IIU-2/M Input Interface Module 5-5
5.4 TEX-P Passive Timing Extraction Module 5-5
5.5 Frequency Converter Module 5-6
5.6 Frequency Amplifier Module 5-7
5.7 Phase Measurement Module 5-8
5.8 Rubidium Interface Module 5-9
5.9 Alarm Module 5-10

6 ADJUSTMENTS 6-1
6.1 Rubidium Clock Frequency 6-3

7 OPERATION 7-1
7.1 Overview 7-3
7.2 User Interface 7-3
7.3 Main Window 7-4
7.4 Setting-Up 7-7
7.5 Diagnostics Functions 7-14
7.6 Data Acquisition - Measuring with WinSTS 7-15
7.7 Measurement Information 7-16
7.8 The File System 7-18
7.9 The Graph Windows 7-20
7.10 Templates (masks) 7-28
7.11 Statistical Functions 7-29
7.12 Filter Function 7-32
7.13 Linear Regression 7-34

8 STS COMMS COMMAND SET 8-1
8.1 Commande List 8-3
8.2 The Diagnostics menu 8-4

9 PREVENTIVE MAINTENANCE & TROUBLESHOOTING 9-1
9.1 Preventive Maintenance 9-3
9.2 Troubleshooting 9-3

9.3 Oscilloquartz Contact Information 9-4

10 DIAGRAMS & DRAWINGS 10-1

10.1 Introduction 10-3

10.2 Block Diagram 10-3

10.3 Front Panel 10-4

10.4 Rear Panel 10-5

11 PRE-DEFINED TEMPLATES 11-1

11.1 Introduction 11-3

11.2 SSU Type Applications 11-3

11.3 Standard Specifications per Equipment Type 11-4

11.4 Network Limit for Wander at PRC Outputs 11-5

11.5 Network Limit for Wander at SSU Outputs 11-7

11.6 Network Limit for Wander at SEC Outputs 11-9

11.7 Network Limit for Wander at PDH Distribution Outputs 11-11

11.8 Wander Generation for PRC 11-13

11.9 Wander Generation for SSU 11-15

11.10 Noise Transfer for SSU 11-23

11.11 Short-term Phase Transient Response for SSU 11-26

11.12 Phase Discontinuity for SSU 11-30

11.13 Wander Generation for SEC 11-34

11.14 Noise Transfer for SEC 11-39

11.15 Short-term Phase Transient Response for SEC 11-40

11.16 Long-term Phase Transient Response (holdover) for SEC 11-41

12 APPLICATION NOTE 12-1

12.1 Introduction 12-3

12.2 Formulas 12-4

12.3 Equipment Noise Measurement 12-5

12.4 Measurement Data Interpretation 12-6

12.5 Measurement Samples 12-8

DOCUMENT HISTORY I

List of Figures Page

Figure 3-1: Line Voltage Connector....3-9
Figure 5-1 Front Panel....5-3
Figure 5-3: IIU-2/M - Front Panel....5-5
Figure 5-4: Frequency Changer - Front Panel....5-6
Figure 5-5: Frequency Amplifier - Front Panel....5-7
Figure 5-6: Phase Measurement - Front Panel....5-8
Figure 5-7: Rubidium Interface - Front Panel....5-9
Figure 5-8: Rubidium Interface - Front Panel....5-10
Figure 7-1 : WinSTS Graph Window Example....7-20
Figure 7-1 : Axes Properties - Dialog Box....7-23
Figure 7-2 : Zoom IN on Graphs....7-26
Figure 7-3 : Zoom OUT on Graphs....7-27
Figure 7-4 : MTIE White Phase Noise Simulation....7-29
Figure 7-5 : ADEV White Phase Noise Simulation....7-30
Figure 7-6 : TDEV White Phase Noise Simulation....7-31
Figure 7-7 : Ym Data Averaging Simulation....7-32
Figure 7-8 : TIE Linear Regression Example....7-34
Figure 7-9 : YM Linear Regression Example....7-36
Figure 10-1 : STS 5565 Block Diagram....10-3
Figure 10-2 : STS 5565 Front Panel....10-4
Figure 10-3 : STS 5565 Rear Panel....10-5
Figure 12-1 : STS 5565 Block Diagram....12-3
Figure 12-2 : System Noise (TIE)....12-9
Figure 12-3 : System Noise (MTIE)....12-10
Figure 12-4 : System Noise (MADEV) Sample....12-11
Figure 12-5 : System Noise (TDEV)....12-12
Figure 12-6 : System Noise (ADEV)....12-13
Figure 12-7 : White Phase Modulation (TIE)....12-14
Figure 12-8 : White Phase Modulation (TIE)....12-15
Figure 12-9 : White Phase Modulation (MADEV)....12-16
Figure 12-10 : White Phase Modulation (TDEV)....12-17
Figure 12-11 : White Phase Modulation (ADEV)....12-18
Figure 12-12 : Flicker Phase Modulation (TIE)....12-19
Figure 12-13 : Flicker Phase Modulation (MTIE)....12-20
Figure 12-14 : Flicker Phase Modulation (MADEV)....12-21
Figure 12-15 : Flicker Phase Modulation (TDEV)....12-22
Figure 12-16 : Flicker Phase Modulation (ADEV)....12-23
Figure 12-17 : White Frequency Modulation (TIE)....12-24
Figure 12-18 : White Frequency Modulation (MTIE)....12-25
Figure 12-19 : White Frequency Modulation (MADEV)....12-26
Figure 12-20 : White Frequency Modulation (TDEV)....12-27
Figure 12-21 : White Frequency Modulation (ADEV)....12-28
Figure 12-22 : Flicker Frequency Modulation (TIE)....12-29
Figure 12-23 : Flicker Frequency Modulation (MTIE)....12-30

Figure 12-24 : Flicker Frequency Modulation (MADEV)....12-31
Figure 12-25 : Flicker Frequency Modulation (TIE)....12-32
Figure 12-26 : Flicker Frequency Modulation (ADEV)....12-33
Figure 12-27 : Random Walk Frequency Modulation (TIE)....12-34
Figure 12-28 : Random Walk Frequency Modulation (MTIE)....12-35
Figure 12-29 : Random Walk Frequency Modulation (MADEV)....12-36
Figure 12-30 : Random Walk Frequency Modulation (TDEV)....12-37
Figure 12-31 : Random Walk Frequency Modulation (ADEV) 12-38
Figure 12-32 : White Phase Modulation + Jump 100 ns (TIE)....12-39
Figure 12-33 : White Phase Modulation + Jump 100 ns (MTIE)....12-40
Figure 12-34 : White Phase Modulation + Jump 100 ns (MADEV)....12-41
Figure 12-35 : White Phase Modulation + Jump 100 ns (TDEV)....12-42
Figure 12-36 : White Phase Modulation + Jump 100 ns (ADEV)....12-43
Figure 12-37 : White Phase Modulation + Frequency Offset 1e-9 (TIE)....12-44
Figure 12-38 : White Phase Modulation + Frequency Offset 1e-9 (MTIE)....12-45
Figure 12-39 : White Phase Modulation + Frequency Drift 8.64e-8/day (TIE)....12-46
Figure 12-40 : White Phase Modulation + Frequency Drift 8.64e-8/day (MTIE)....12-47
Figure 12-41 : White Phase Modulation + Frequency Drift 8.64e-8/day (MADEV)....12-48
Figure 12-42 : White Phase Modulation + Frequency Drift 8.64e-8/day (TDEV)....12-49
Figure 12-43 : White Phase Modulation + Frequency Drift 8.64e-8/day (ADEV)....12-50
Figure 12-44 : White Phase Modulation + Phase Modulation 1e-8sin(pi*t/100) (TIE)....12-51
Figure 12-45 : White Phase Modulation + Phase Modulation 1e-8sin(pi*t/100) (MTIE)....12-52
Figure 12-46 : White Phase Modulation + Phase Modulation 1e-8sin(pi*t/100) (MADEV)....12-53
Figure 12-47 : White Phase Modulation + Phase Modulation 1e-8sin(pi*t/100) (TDEV)....12-54
Figure 12-48 : White Phase Modulation + Phase Modulation 1e-8sin(pi*t/100) (ADEV)....12-55
Figure 12-49 : White Phase Modulation + Phase Modulation 1e-8sin(pi*t/64) (TIE)....12-56
Figure 12-50 : White Phase Modulation + Phase Modulation 1e-8sin(pi*t/64) (MTIE)....12-57
Figure 12-51 : White Phase Modulation + Phase Modulation 1e-8sin(pi*t/64) (MADEV)....12-58
Figure 12-52 : White Phase Modulation + Phase Modulation 1e-8sin(pi*t/64) (TDEV)....12-59
Figure 12-53 : White Phase Modulation + Phase Modulation 1e-8sin(pi*t/64) (ADEV)....12-60

List of Tables Page

Table 3-1 Alarm Connectors....3-10
Table 3-2 RS232 for WinSTS Pinout....3-11
Table 3-3 NULL MODEM cable....3-11
Table 6-1 Rubidium Adjustment - Fractional Frequency Steps....6-4
Table 11-1 SSU Type Applications....11-3
Table 11-2 Standard Specifications per Equipment Type....11-4
Table 12-1 Perturbation Effects on MTIE....12-6
Table 12-2 Perturbation Effects on TDEV....12-7
Table 12-3 Perturbation Effects on ADEV....12-7
Table 12-4 Perturbation Effects on MADEV....12-7
Table 12-5 Ordering Cards....A-1
Table 12-6 Ordering Accessories & Options....A-1

List of Procedures Page

Procedure 4-1 Software Installation....4-3
Procedure 4-2 General Connections....4-4
Procedure 4-3 Turn-On....4-6
Procedure 6-1 Rubidium Clock Frequency Adjustment....6-3
Procedure 7-1 RS232 Serial Link Set-up....7-7
Procedure 7-2 Signals Configuration....7-8
Procedure 7-3 Saving Current Configuration....7-10
Procedure 7-4 Loading Predefined Configuration....7-11
Procedure 7-5 Squeduling an aquisition....7-13

This page has been intentionally left blank

Chapter

1 Introduction

Including :

- About this Manual
- Reading Guide
- Safety
- Warranty
- Certification

This page has been intentionally left blank

1.1 About this Manual

This manual has been designed to provide basic and detailed information for the correct use and operation of the OSA 5565. It summarizes the overall equipment concept and theory of operation, describes the hardware itself and provides information related to installation, operation and maintenance.

It is intended for the use of the following types of users:

Systems Engineers:	An overview of the equipment concept and theory of operation.
Installation Engineers:	Detailed technical information and procedures for correct installation, operation, configuration and commissioning as well as equipment specifications and maintenance guidelines.
Maintenance Engineers:	Information on troubleshooting, maintenance and equipment technical data.

1.1.1 Copyright Notice

Copyright © 2010 Oscilloquartz SA
All Rights Reserved

The Oscilloquartz product described in this book is furnished under a license agreement and may be used only in accordance with the terms of the agreement.

The contents and information in this document are provided in connection with Oscilloquartz products. No license, expressed or implied by estoppels or otherwise, to any intellectual property rights is granted by this document. Except as provided in Oscilloquartz SA's Terms and Conditions of Sale for such products.

This document is exclusive property of Oscilloquartz SA and may not, in whole or in part, be copied, photocopied, reproduced, modified, translated, reduced to any electronic medium or machine-readable, stored in a retrieval system, or transmitted in any form without prior consent in writing from Oscilloquartz SA, Brévards 16, 2002 Neuchâtel 2, Switzerland.

Every effort has been made to ensure the accuracy of this guide. However, Oscilloquartz SA makes no warranties with respect to this documentation and disclaims any implied warranties of merchantability and fitness for a particular purpose. Oscilloquartz SA shall not be liable for any errors or for incidental or consequential damages in connection with the furnishing, performance, or use of this manual or the examples herein.

Oscilloquartz SA may make changes to specifications and product descriptions at any time, without notice.

1.2 Reading Guide

Special icons, attracting your attention, precede important and/or critical information in this document. Hereafter are explanations of each icon.

CAUTION

This symbol is extremely important and must not be neglected. It precedes information or procedures regarding installation, operation or maintenance. Follow all steps or procedures, as instructed, to avoid any damage to equipment or serious personal injury.

ELECTRICAL SHOCK HARZARD

This warning symbol is extremely important and must not be neglected. It indicates that there are dangerous high voltages present inside the enclosure of this product and precedes important warnings to avoid any risk of fire or electrical shock that could lead to serious personal injury or loss of life.

ESD CAUTION

Electrostatic Discharge (ESD) must be avoided so as not to damage or destroy static sensitive components.

***Note*:**

A note symbol informs the reader that additional information on the related subject is provided in order to simplify a described task, suggest other references or even just simplify an explanation.

Recommendation:

Recommendations advise the user on manufacturer tested methods and procedures proven valuable for correct use and optimum equipment results.

1.3 Safety Instructions

IMPORTANT SAFETY INSTRUCTIONS.
DO NOT DISCARD, READ BEFORE OPERATING

GENERAL

Exercise extreme care when handling any electronics equipment as it contains precision parts that can be damaged by improper handling.

Avoid touching connector pin surfaces. Foreign matter deposited on contact surfaces can cause corrosion, and eventually lead to degradation of performance. In addition, do not use abrasives to clean contact/pin surfaces.

ESD CONSIDERATION

Each module contains semiconductor devices that can be damaged by electrostatic discharges. It is advisable to take anti-static precautions when handling electronic boards or static sensitive components. Use an approved anti-static bracelet in accordance with company practice.

WATER AND MOISTURE

Do not place containers with liquids such as coffee, water, sodas, etc. on this unit. Do not operate this equipment in a wet environment.

HEATING

Do not install this product near heat sources such as radiators, air ducts, areas subject to direct, intense sunlight, or other products that produce heat.

VENTILATION

Slots and openings in the chassis are provided for ventilation and to ensure reliable operation of the product. To protect the unit from overheating, those openings must not be blocked or covered. When integrating this unit in a rack cabinet, at least one inch (2.5 cm) of clearance above and below the unit is necessary to assure sufficient cooling.

GROUNDING

EARTH CONNECTION IS ESSENTIAL BEFORE CONNECTING TO THE SUPPLY.

The OSA 5565 must be connected to Earth Ground (common bounding network (DC-C)). The wire used for the connection must be a minimum of AWG16.

Ensure that all other devices connected to the 5565, are connected to protective (earth ground). (Grounding one conductor of a two-conductor outlet is not sufficient.)

Any interruption of the protective (grounding) conductor (inside the equipment) or disconnecting the protective earth terminal is likely to make this equipment dangerous. Intentional interruption is prohibited.

POWER

Make sure the power sources are compatible with the power inputs of the equipment. Verify that the correct fuses are installed. The equipment's protective earth terminals must be connected to the protective conductor of the (mains) power cord or the station earth. The mains plug shall only be inserted in a socket outlet provided with a protective earth contact. The protective action must not be negated by the use of an extension cord (power cable) without a protective conductor (grounding).

Make sure that only fuses with the required rated current and of the specified type (normal blow, time delay, etc.) are used for replacement. The use of repaired fuses and the short-circuiting of fuse holders must be avoided.

Whenever it is likely that the protection offered by fuses has been impaired, the equipment must be made inoperative and be secured against any unintended operation

POWER CORD PROTECTION

The power supply cord for this product should be routed or installed in such a manner to protect it from being walked on or pinched. The unit should be powered down completely before connecting or disconnecting the power cable. The power cord should be removed before moving the unit. The power cord must be placed near an easily accessible unobstructed socket outlet.

CLEANING

Connected and running equipment can only be dusted using a soft dry cloth.

ONLY WITH**, <u>AUTHORIZED PERMISSION</u>,** OUT OF SERVICE & UNPLUGGED equipment can be cleaned with a soft cloth slightly moistened with a mild detergent solution. Do not use liquid cleaners, aerosols, abrasive pads, scouring powders or solvents, such as benzine or alcohol. Ensure the surface cleaned is fully dry before reconnecting power.

SERVICING AND MODIFICATIONS

To avoid dangerous electric shock, do not perform any servicing or modifications other than what is recommended in this User Manual. Do not attempt to gain access to areas of the unit where dangerous voltages are present. Refer servicing to qualified service personnel.

DAMAGE REQUIRING SERVICE

- Refer servicing to qualified service personnel under the following conditions:
- When the power supply cord is damaged.
- If liquid has been spilled into the enclosure of the unit.
- If the product does not function normally by following the instructions in the User's Manual. Adjust only those controls that are covered by the operating instructions. Improper adjustment of other controls may result in damage and will often require rework by a qualified technician to restore the product to its normal operation.
- If the product has been damaged in any way.

When the unit displays a negative, distinct change in performance.

1.4 Warranty

This Oscilloquartz product carries a warranty which commences from date of dispatch from factory. Unless agreed otherwise or stipulated differently on the original acknowledgement of order, the duration of the warranty is twenty four months.

It applies to demonstrably faulty material or poor workmanship, but excludes batteries.

Oscilloquartz shall bear only the cost of repair or replacement in its own premises. Should this not be possible for reasons beyond our control, all additional costs are at customer expense.

Repairs under warranty carry either the balance of the original warranty or a six months warranty, whichever is longer.

Damages resulting from natural wear, improper maintenance, failure to observe the operating instructions, excessive strain, unsuited consumption material as well as improper environmental and mounting conditions are excluded from this warranty.

The warranty expires if the customer or a third party modifies or repairs the product without Oscilloquartz's prior written consent or if the customer does not take immediate steps to prevent the damage from becoming more serious; likewise, if insufficient time is provided for repair or replacement.

The customer will not be entitled to other warranty claims. Oscilloquartz is not liable for consequential damage.

1.5 Certification

EQUIPMENT CERTIFICATION:

Oscilloquartz equipment is tested according to well-defined procedures. Appropriate testing and inspection takes place at the component, board, equipment and system levels. The company maintains in-house cesium standards that are continuously compared to UTC. Before any equipment is released, it must satisfy the relevant tests and inspection schedules. The equipment is then issued with a "Certificate of Conformity" that guarantees its conformance with the relevant performance criteria.

The OSA 5565 STS is designed to be compliant to:

- SAFETY : EN61010-1: 1993 / A2: 1995
- EMC : EN50081-1, EN50082-1

A variety of Oscilloquartz products are certified world-wide. For details, please refer to our web site at www.oscilloquartz.com

COMPANY CERTIFICATION:

- Certified since 1987 by the Swiss Accreditation Service and Swiss Federal Office of Metrology as an accredited laboratory for time and frequency.

- Certified ISO 9001 since 1994 and ISO 14001 since 2000 by The Swiss Association for Quality and Management Systems (SQS)

This page has been intentionally left blank

Chapter

2 General Description

Including :

- Overview

This page has been intentionally left blank

2.1 Overview

The STS (Synchronisation Test Set) is a portable instrument combining a Rubidium clock and a phase-time measurement instrument in one piece of equipment. It is intended for the measurement of the quality of synchronisation signals in telecommunication networks. The STS runs in conjunction with an IBM compatible PC. A program called WinSTS performs the control of the STS instrument and produces the mathematical calculations. The main functions of the set are:

- Provision of a high stability reference signal generated by its internal Rubidium clock.
- Measurement of the Time Interval Error (TIE) of a synchronisation signal.
- Calculation of the following signal parameters, derived from the TIE raw data:
  - MTIE
  - ADEV
  - MADEV
  - TDEV
  - $\Delta f/f_o$

The STS can accept a wide variety of input signals in the frequency range of 64 kHz to 16’384 kHz by step of 8 kHz. A field exchangeable input interface card allows the STS to be connected to different types of input signals (sine, square, code).

The reference signal from the Rb clock is available on BNC connectors as a standard 10 MHz signal, and as an additional output signal whose frequency can be configured by way of to two field exchangeable cards (a frequency converter card and an amplifier or code generator card).

The STS can also be connected to an external reference signal, which then replaces the internal Rb clock reference.

Note:

The terms used in this document refer to the figures in **chapter 10** showing the front panel, the rear panel and the block diagram of the system.

This page has been intentionally left blank

Chapter

3 Specifications

Including :

- Input Line IN
- Input AUX
- Input EXT.REF
- Output REF OUT
- Outputs OUT 1, OUT 2
- Phase Measurement Unit
- Internal Reference Oscillator
- Mechanical
- Environmental
- Power Supply
- Connector Pin-Out

This page has been intentionally left blank

3.1 Input Line IN

Different types of input receivers are available:

IIU-6/M	ITU G.703-6/75Ω (also through TEX-P, 18dB att.) (preset: HDB3/CAS)
IIU-2/M ESF	ITU G.703-2/75Ω (preset: B8ZS/ESF)
IIU-2/M D4(SF)	ITU G.703-2/75Ω (preset: AMI/D4)
IIU-10/M (three frequency bands)	ITU G.703-10/75Ω
Connector	BNC (A1X1 on front panel)

3.1.1 IIU-6/M (2.048 Mbit/s)

Direct connection to an IIU-6/M is only possible if the line is properly terminated.

Input signal	HDB3/CAS (Factory pre-configuration)
Input level	According to G-703/6 (2.37Vp/75Ω) min. V nominal-10dB, max. 2.8 Vp **OR** According to G-703/6 -18dB (0.3Vp/75Ω) min. V nominal-28dB, max. 0.5Vp)
Input impedance	75 Ω (coax.)
Mismatching loss	< -20 dB, 0.1 MHz < f < 2 MHz < -15 dB, 2 MHz < f < 3 MHz
Added noise level (1Hz<f<0.1MHz)	< 60 mVpp, sinusoïdal

3.1.1.1 TEX-P

Using a TEX-P enables operation on a 2.048 Mbit/s link without interrupting it. The TEX-P allows the extraction of part of the signal without interrupting the data flow. The extracted signal is then input to a n module.

Input signal	according to ITU G.703/6
'Input - output' attenuation	< 0.5 dB, 0.1 MHz < f < 3 MHz
'Input - active output' attenuation	18 dB +/- 1dB, 0.1 MHz < f < 3 MHz
Input impedance	75 Ω (coax.)
Output impedance	75 Ω (coax.)
Impedance of active output	75 Ω coax.
Mismatching loss (50 Ω)	< -20 dB, 0.1 MHz < f < 3 MHZ
Connector	BNC 75 Ω

3.1.2 IIU-2/M ESF and IIU-2/M D4 (1.544 Mbit/s)

Input signal		B8Z2/ESF or AMI/D4 (Factory pre-configuration)
Supply voltage		24 V ±10%
Input signal	Signal shape: Nominal amplitude: Minimum amplitude: Impedance: Number of inputs:	According to G703/2 3V peak Unom -35dB (For use with TEX-P) 75 Ohms 1
Reference signal	Signal shape: Nominal amplitude: Minimum amplitude	Sinus or square wave 0.5 Vrms 50 mVrms
Alarm signal	Number of signals: Type: Vc max: Ic max:	1 Opto-coupler 50V (off state) 5mA (on state)
Temperature range	Operation:	0 ÷ 60 °C

3.1.3 IIU-10/M

Use an IIU-10/M input interface if the incoming synchronisation signal is already a clock signal.

Signal type	sine wave or square wave
Level	sine : 0.3 Vrms to 1.5 Vrms square: 1 Vpp to 5 Vpp (40% < δ < 60%)
Input Impedance	75 Ω (coax)
Input frequency (three models)	64 kHz to 2 MHz or 2 MHz to 32 MHz or 15 MHz to 50 MHz (with fout = fin / 4)
Added noise level	< 50 mVpp

3.2 Input AUX

Signal type	sine wave or square wave
Level	sine : 0.3 Vrms to 1.5 Vrms square: 1 Vpp to 5 Vpp (40% < δ < 60%)
Input Impedance	50 Ω (coax)
Frequency	64 kHz to 16384 kHz by step of 8 kHz
Connector (A1X2 on front panel)	BNC 50 Ω

3.3 Input EXT.REF

Signal type	sine wave or square wave
Level	sine : 0.1 Vrms to 1.5 Vrms square: 1 Vpp to 5 Vpp (40% < δ < 60%)
Input Impedance	50 Ω (coax)
Frequency	10 MHz
Connector (A1X3 on front panel)	BNC 50 Ω

3.4 Output REF OUT

Signal type	square wave
Level	2.2 V_{PP}
Input Impedance	50 Ω (coax)
Frequency	10 MHz from active reference
Connector (A1X6 on front panel)	BNC 50 Ω

3.5 Outputs OUT 1, OUT 2

Two identical outputs from:

Output Amplifier:	
Signal type	sine
Level	7 dBm
Input Impedance	75 Ω (coax)
Frequency	one value from the following list: - 1.544 MHz - 2.048 MHz - 4.096 MHz - 10 MHz - 44.736 MHz - 139.264 MHz
or Code Generator : HDB3	
Connectors (A1X4, A1X5 on front panel	BNC 75 Ω

3.6 Phase Measurement Unit

Sampling period τ_0	12.5 ms
Max. measurement period T	limited by RAM installed on PC
Resolution	100 ps
Max. measurement range	± 100 µs (with recycling)

3.7 Internal Reference Oscillator

5565-02

Type: Rubidium	MCFRS-01
Frequency	10 MHz
Temperature Stability	2E-10 for Θ = 0 to 60 °C
Phase stability	ADEV(1s) = 3E-11 ADEV(10s) = 1E-11 ADEV(100s) = 3E-1
Drift per month	4E-11 (after 2 months of continuous operation
Retrace	2E-11 >1 h 24 h interruption
Adjustment rang	min 4E-9
Adjustment resolution	min 1E-12/unit (LSB)

Recommendation:

The calibration is done in a position and when the position's device changes, the magnetic earth field modifies the precision of the Rb clock by $\leq 1 \cdot E^{-10}$/gauss.

3.8 Mechanical

Size (h x w x d)	145 x 275 x 400 mm
Weight	7.5 kg

3.9 Environmental

Operating temperature range	0° to +45°C
Storage temperature	-20°C to 50°C
Humidity	Up to 95% non condensing

3.10 Power Supply

3.10.1 Line voltage

	Model AC	with AC/DC Converter 230VAC ±10% or 115VAC ±10%/50-60 Hz
Fuses F1, F2		with AC/DC Converters: T 3,15A L 250V, 5 x 20 mm
Power		< 50 W typical during warm-up < 40 W typical during normal operation (depending on configuration)

3.10.2 Line Voltage Connector (A9X1 on rear panel)

For AC Voltage:

Schurter 5220.0423.1

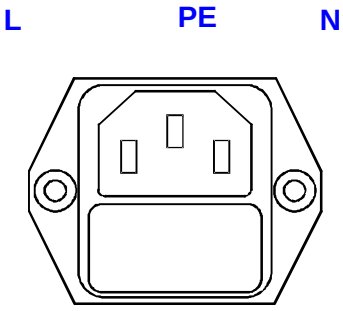


Figure 3-1: Line Voltage Connector

3.11 Connector Pin-Out

3.11.1 Connector 'ALARMS' (Sub-D 25p A9X3 on rear panel)

This connector provides electrical contacts for alarm signals generated by the alarm card. The version 942.085.516.01 is equipped with relays. For this version contact 1 is the common, contact 2 is the relay contact that closes when the alarm is active, contact 3 is the relay contact that opens when the alarm is active. The version 942.085.516.02 is equipped with opto-couplers. There are alarms for the individual modules and summarizing alarms called 'General alarms'. In the pin-out table, 'A', 'B' and 'C' refer to different relays or opto-couplers with the same logical alarm signal.

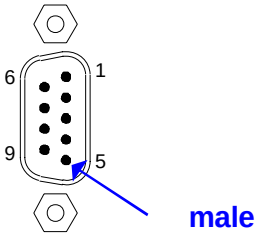
Pin Nr.	Alarm Card with Relays 942.085.516.01	Alarm Cards with Opto-Couplers 942.085.516.02
1	NC	Power supply A, collector
2	General alarm A, contact 1	Power supply B, collector
3	General alarm B, contact 2	Input interface, collector
4	General alarm B, contact 3	Output interface 1, collector
5	General alarm C, contact 1	Rubidium interface, collector
6	NC	Phase measurement, collector
7	NC	Output interface 2, collector
8	NC	General alarm, collector
9	NC	NC
10	Lamp test, signal	Lamp test, signal
11	NC	NC
12	NC	NC
13	NC	NC
14	General alarm A, contact 1	Power supply A, emitter
15	General alarm A, contact 2	Power supply B, emitter
16	General alarm B, contact 1	Input interface, emitter
17	General alarm C, contact 2	Output interface 1, emitter
18	General alarm C, contact 3	Rubidium interface, emitter
19	NC	Phase measurement, emitter
20	NC	Output interface 2, emitter
21	NC	General alarm, emitter
22	NC	NC
23	Lamp test, 0 V	Lamp test, 0 V
24	NC	NC
25	NC	NC

Table 3-1 Alarm Connectors

3.11.2 Connector 'RS-232' (Sub-D 9p A9X4 on rear panel)

This connector is the RS-232C port used to connect the OSA 5565 STS to the PC that executes the control software. Please use a NULL MODEM cable.

3.11.2.1 "RS-232C" Pin-out



Pin No.	Description
2	Rx
3	Tx
5	Ground
1,4,6,7, 8,9	no connection

Table 3-2 RS232 for WinSTS Pinout

3.11.2.2 NULL MODEM cable Pin-out

DB9 (side 1)		DB9 (side 2)	
Name	Pin N°	Name	Pin N°
RxD	**2**	**TxD**	**3**
TxD	**3**	**RxD**	**2**
DTR	4	DSR+CD	6+1
GND	**5**	**GND**	**5**
DSR+CD	6+1	DTR	4
RTS	7	CTS	8
CTS	8	RTS	7

Table 3-3 NULL MODEM cable

This page has been intentionally left blank

Chapter

4 Installation & Turn-On Procedure

Including :

- Required Hardware Configuration
- Software Installation
- Selection of the Printer Type
- Connections
- Turn-On Procedure
- Starting up the WinSTS Program

This page has been intentionally left blank

4.1 Required Hardware Configuration

For the installation and commissioning of the OSA 5200B, the following tools are needed:
:

Operating System : Windows 2000 SP4, Windows 2003 or WindowsXP SP2.

For more information, please refer to the Microsoft Website (http://www.microsoft.com/). WinSTS needs to have Microsoft **.NET Framework 2.0** and **Windows Installer.**

4.2 Software Installation

From a CD-ROM
To install the program from the CD-ROM drive D: to the hard disk C: of your PC, proceed as follows:

STEP	ACTION
1	Insert the CD-ROM into CD-Rom drive **D** of your PC.
2	Navigate to the software introduction page. "Click on Software Installation" which will open the .exe file.
3	The program is now being automatically installed

Procedure 4-1 Software Installation

For further information on managing programs, see your Windows operating system documentation.

4.3 Selection of the Printer Type

If a printer is connected to your PC, set the printer type using the Windows control panel. WinSTS uses the standard windows printing procedures.

4.4 Connections

4.4.1 General Connections

STEP	ACTION
1	Connect the ground cable to the ground connector ‘A9X2’ of the STS (rear panel)
2	Connect the STS to the PC: Make an RS-232C connection between the A9X4 connector of STS (rear panel) and one of the serial ports of the PC. The RS-232C cable must invert the lines 2 and 3.
3	Connect the STS to the power line (connector A9X1, rear panel)

Procedure 4-2 General Connections

4.4.2 Input Signal Connection

The STS has two inputs for the signals that are to be measured (refer to the block diagram, **chapter 10**)

Input ‘IN’:
The signal is amplified and adapted by the input interface card ‘A2’, before it is fed to the measurement card ‘A5’. The type of input signal accepted by this input depends on the input interface card that sits in the ‘A2’ slot of the instrument. The input interface card is field exchangeable. Refer to **section 3.1** and Oscilloquartz product catalogue for available input interface cards.

Input ‘AUX IN’:
The input signal is fed directly to the measurement card ‘A5’. This input accepts any signal with the following caracteristics:

- - frequency = 64 kHz to 16384 khz, multiples of 8 kHz
- - square wave with 1 to 5 V_{pp} amplitude
- - sine wave with 0.1 to 1.5 V_{RMS} amplitude
- - input impedance = 50 Ohm, asymetrical

Connect the signal to be measured either to the input ‘IN’ or to the input ‘AUX IN’. The measured input is selected by the user with ‘Configure’ menu when STS connected. (refer to **section 7.4**)

4.4.3 External Reference Connection

If you decide to use an external reference source (e.g. a Cs clock) instead of the built in Rb clock, then connect the 10 MHz signal from your reference source to the input 'EXT REF'. The reference used for the measure is selected by the user with 'Configure' menu when STS connected. (refer to **section 7.4**)

The STS features three reference output signals:

- Output 'REF OUT' is a 10 MHz signal derived directly from the reference (internal or external, depending on which one is used for the measurement).

- Outputs 'OUT 1' and 'OUT 2' are two identical signals derived from the reference signal and transformed by the frequency converter A4 and the output amplifier or Code Generator A3 (A4 can be replaced by a dummy card if no frequency conversion is needed).

The above mentioned reference output signals are used when the measured signal is the response from a system under test that requires an excitation clocking signal as an input.

4.5 Turn-On Procedure

If you have followed the connection indications of section 4.4, the STS should already be powered up. Now follow these steps:

STEP	ACTION
1	Depress the RESET toggle switches on all cards that are fitted with one. The LEDs indicating memorised (latched) alarms (right LED column) should go out.
2	Check all the LEDs by depressing the LAMPTEST toggle switch of 'Alarm module'; all LEDs should light up momentarily.
3	Wait until the LED 'AL' on the 'φ-MEASURE' card and the yellow LED ''W-UP' on the Rb Interface card go out. This should take ≤ 10 minutes (warm-up period for the Rb clock to reach frequency offset ≤ 2E-10 of final frequency). When the 'W-UP' LED goes out, the green LED 'LOCK' on the Rb interface card should light up. If the LED 'AL' on the 'φ-MEASURE' card light up, verify the configuration (see section 7.4).
4	The STS is now ready. However, for best results the warm-up period should be extended to a couple of hours. The Rb clock will then have reached its nominal frequency stability.

Procedure 4-3 Turn-On

4.6 Starting up the WinSTS Program

Please refer to **chapter 7**

.

Chapter

5 Modules Description

Including :

- IIU-10/M Input Interface Module
- IIU-6/M Input Interface Module
- IIU-2/M Input Interface Module
- Frequency Converter Module
- Frequency Amplifier Module
- Phase Measurement Module
- Rubidium Interface Module
- Alarm Module

This page has been intentionally left blank

5.1 IIU-10/M Input Interface Module

The IIU-10/M module (A2) ensures isolation between the incoming input signal and the system. It also performs the monitoring of the signals and the signal conditioning needed to ensure compatibility with the Phase Measurement module. An alarm signal is instantly transmitted to the alarm module, if either the signal level is out of specification or the module shows a failure.

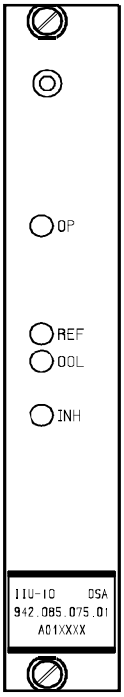


Figure 5-1 Front Panel

TEXT	COLOR	FUNCTION
OP	Green	When on, indicates that the module is operating. The incoming reference signal is transmitted to the output of the module.
REF	Red	When on, indicates that the signal at the input of the module is not valid.
OOL	Red	When on, indicates a function inhibit caused by input 1 (not used).
INH	Red	When on, indicates that a digital input inhibits the IIU module.

Table 5-1 IIU-10/M LED Description

5.2 IIU-6/M Input Interface Module

The 'IIU-6/M' input interface module (A2) ensures galvanic isolation between the incoming reference signal and the system. It extracts the CAS framed clock signal and detects AIS alarms. With the 'IIU-6/M' module it is also possible to extract other information from the HDB3 line, such as FA and ER alarms. It can also be used to generate an alarm signal derived from monitoring the input signal level.
In the case of a malfunction (incoming signal out of specification or failure of the module), an alarm signal is instantly transmitted to the alarm module.

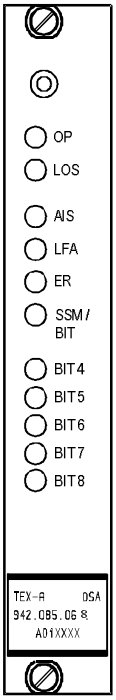


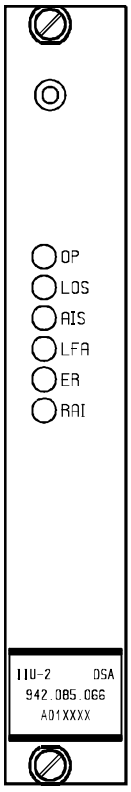
Figure 5-2: IIU-6/M - Front Panel

TEXT	COLOR	FUNCTION
OP	Green	When on, indicates that the module is in the operational mode and its output signals are valid.
LOS	Red	When on, indicates a LOS condition in the input signal.
AIS	Red	When on, indicates an AIS condition in the input code..
LFA	Red	When on, indicates one or more of the following conditions in the input code. (depending on the defined alarm mask). Loss of frame alignment. Loss of CRC-4 alignment. Loss of CAS multiframe alignment.
ER	Red	When on, indicates an Error Rate condition in the input code. Depending on the selected alarm mask, the limit error rate can be 1E-3 or 1E-4.
SSM / BIT	Red	When on, indicates one of the three following conditions (depending on the defined alarm mask): 1)The input signal is rejected, according to the SSMB algorithm. (Future option). 2)One or more bits Sa4 to Sa8 are in the state declared in the alarm mask. 3) A remote alarm (Bit 3 at high state) has been detected.
BIT 4	Yellow	Indicates the state of the additional bit Sa4.
BIT 5	Yellow	Indicates the state of the additional bit Sa5.
BIT 6	Yellow	Indicates the state of the additional bit Sa6.
BIT 7	Yellow	Indicates the state of the additional bit Sa7.
BIT 8	Yellow	Indicates the state of the additional bit Sa8.

Table 5-2 IIU-6/M LED Description

5.3 IIU-2/M Input Interface Module

The 'IIU-2/M' input interface module (A2) extracts the clock from a D4 or ESF framed signal and provides several levels of information and alarms criteria.
It also has the capability to measure the phase difference between the input signal and the equipment's local reference.
In the case of a malfunction (incoming signal out of specification or failure of the module), an alarm signal is instantly transmitted to the alarm module.

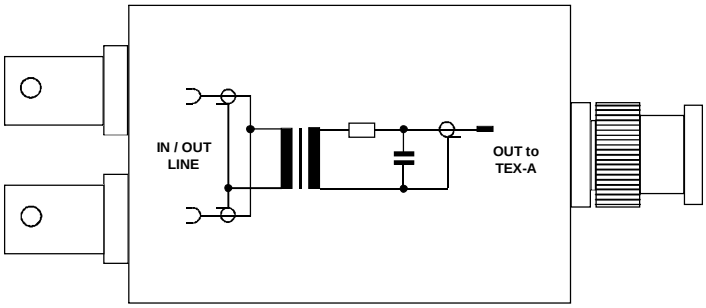


TEXT	COLOR	FUNCTION
OP	Green	When on, indicates that the module is operating.The incoming reference signal is transmitted to the output of the module.
LOS	Red	When on, indicates a LOS condition in the input signal.
AIS	Red	When on, indicates that an AIS (Alarm Indication Signal) alarm signal was detected on the line.
LFA	Red	When on, indicates the detection of an error in the synchronisation frame.
ER	Red	When on, indicates the detection of the synchronisation frame error rate having exceeded $1*10^{-3}$ during the last 5 seconds.
RAI	Red	**D4** mode: When on, indicates that bit 2 of consecutive channels is set to zero for at least 254 occurrences. **ESF** mode: When on, indicates that 16 consecutive patterns of 00FF appear in the FDL.

Table 5-3 IIU-2/M LED Description

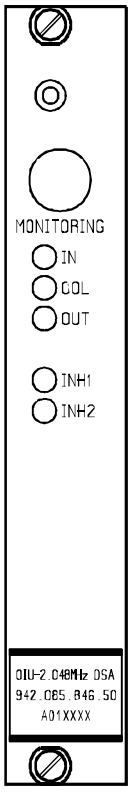
Figure 5-3: IIU-2/M - Front Panel

5.4 TEX-P Passive Timing Extraction Module



5.5 Frequency Converter Module

The 'Frequency Changer' module (A4) receives its input from the selected reference source. The output signal is obtained by an 'on card' phase-locked VCXO.



TEXT	COLOR	FUNCTION
IN	Red	When on, indicates that the input signal is absent or out of specification.
OOL	Red	When on, indicates that the 'on card' VCXO is not locked to the input frequency.
OUT	Red	When on, indicates that the output signal is absent or out of specification.
INH1	Red	When on, indicates an inhibition of the function caused by input 1(not used).
INH2	Red	When on, indicates an inhibition of the function caused by input 2(not used).

Table 5-4 Frequency Changer LED Description

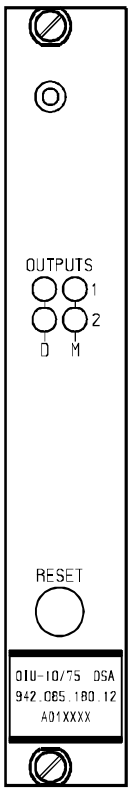
Figure 5-4: Frequency Changer - Front Panel

MONITORING	Level	typ. 50 mVrms (20dB below module output level)
	Impedance	50 Ω
	Connector	LEMO size 00, type RA 00250

Connector : LEMO size 00, type RA 00250)

5.6 Frequency Amplifier Module

The ‘Frequency Amplifier’ module (A3) receives its input signal from the ‘Frequency Changer’ module and amplifies it in order to provide output signals with the correct voltage level and impedance.



TEXT	COLOR	FUNCTION
1	Red	When on, indicates that output 1 is absent or out of specification (G.703/10)
2	Red	When on, indicates that output 2 is absent or out of specification (G.703/10)

Table 5-5 Frequency Amplifier LED Description

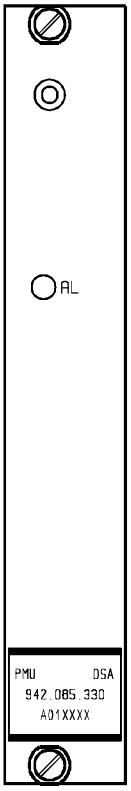
Figure 5-5: Frequency Amplifier - Front Panel

The LEDs marked with a ‘D’ correspond to a direct alarm, those marked with a ‘M’ correspond to a memorised (latched) alarm. The RESET switch clears the ‘M’ LEDs.

5.7 Phase Measurement Module

The main functions of the‘Phase Measurement’ module (A5) are:

1 -. Measurement of the phase variation between the input signal IN or AUX and the selected reference source INT or EXT.
2 - Communication with the PC via the RS-232C
3 - Monitoring the validity of the measurement



TEXT	COLOR	FUNCTION
AL	Red	When on, indicates that at least one of the following conditions are presents: 1 - ‘On card’ VCXO output signal absent 2 - ‘On card’ VCXO not locked 3 - Input signal absent 4 - If selected, internal reference source (Rb clock) not locked 5 - Frequency offset of input signal > 1E-5, correspond to ΔTIE>125 ns for period of 12.5 ms. No measurement error for ΔTIE<500 ns for period of 12.5 ms.

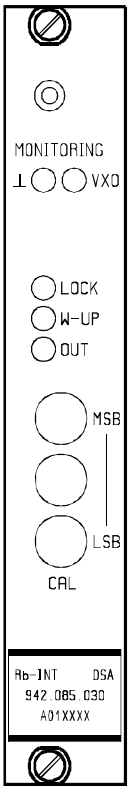
Table 5-6 Phase Measurement LED Description

Figure 5-6: Phase Measurement - Front Panel

5.8 Rubidium Interface Module

The main functions of the‘Rubidium Interface’ module (A6) are:

1- Conditionning of the Rb clock signal. (Shaping and Buffering)
2- Monitoring of the operating conditions of the Rb clock
3- Setting of the Rb control voltage.



TEXT	COLOR	FUNCTION
LOCK	Green	When on, indicates that normal conditions are respected. Monitoring voltage must be: 2.4 V < Umon < 8 V
W-UP	Yellow	When on, indicates that Rubidium reference source is in its warm-up phase
OUT	Red	When on, indicates that the output signal is absent

Table 5-7 Rubidium Interface LED Description

The CAL switches are digital potentiometers that are used for the frequency adjustment of the rubidium reference source.

Figure 5-7: Rubidium Interface - Front Panel

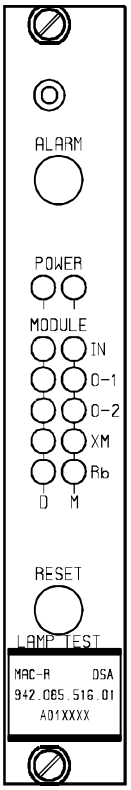
Note:

If "LOCK" LED is switched off (after the warm-up time, ~20 mn), then the Rb reference source needs readjustment of its internal VCXO:

1) on STS model 5565-02, please return the STS to the factory.

5.9 Alarm Module

The ‘Alarm’ module (A7) displays and stores the alarm signals of all modules of the system. It also allows the testing of all LEDs of the system.



TEXT	COLOR	FUNCTION
ALARM	Red	This LED is an image of the general alarm, it is on when at least one direct alarm is present.
POWER	Red	When on, indicates an alarm from the voltage converter A7.
IN	Red	When on, indicates an alarm from the input module A2 (TEX or L.R.)
O-1	Red	When on, indicates an alarm from the output module A3.
O-2	Red	When on, indicates an alarm from the frequency changer module A4.
XM	Red	When on, indicates an alarm from the phase measurement module A5.
Rb	Red	When on, indicates an alarm from the rubidium interface module A6.

Table 5-8 Alarm Module LED Description

Figure 5-8: Rubidium Interface - Front Panel

The LEDs marked with a ‘D’ correspond to a direct alarm, those marked with an ‘M’ correspond to a memorised (latched) alarm. The RESET switch clears the ‘M’ LEDs.

The RESET switch has three positions:

- Mid position: Neutral position
- Upper position: Clearing the memorised alarms
- Lower position: Test of all LEDs on the STS

Chapter

6 Adjustments

Including :

- Rubidium Clock Frequency

This page has been intentionally left blank

6.1 Rubidium Clock Frequency

The frequency of the internal reference source (the Rb clock) can be adjusted by following this procedure:

STEP	ACTION
1	Connect the external reference source, to which you want to adjust the Rb clock, to the input **AUX** (A1X2 of front panel).
2	Start the WinSTS program (refer to **section 7.2**).
3	Click on the **'STS Connected'** checkbox to enable the serial communications link between the STS unit and the PC.
4	From the main window, click on the menu **'Configure'**, then **'STS Configuration'**. The configuration dialogue box will then appear (refer to **section 7.4**).
5	Now select the following STS configuration: - **Aux freq.(kHz)** = frequency of your external reference source. - **Input** = AUX - **Reference** = INT These settings take effect immediately after they are entered.
6	Exit the configuration by clicking on the close button.
7	In the main window, set the following values in the sample and rate edit boxes(refer to **section 7.4**): - **Sample** = 10000 - **Rate** = 1s
8	Start a data acquisition by clicking on the **'Start'** button.
9	From the main window, click on the menu **'Data'** and then select **'TIE'** to open a TIE graph window. Observing the TIE[s] versus t[s] graph, adjust the three digi-switches on the Rb Interface module until the curve becomes horizontal (you may need to adjust the graph axis scales first if the curve is not visible). The digi-switches adjust the fractional frequency of the Rb clock with the steps shown in the following table.

Procedure 6-1 Rubidium Clock Frequency Adjustment

		Δy/step
		5565-02
MSB	upper digi-switch	2.5E-10
	mid digi-switch	1.6E-11
LSB	lower digi-switch	1E-12

Table 6-1 Rubidium Adjustment - Fractional Frequency Steps

If the TIE vs. t curve shows a negative slope, then turn the digi-switches anticlockwise; if the TIE vs. t curve shows a positive slope, turn the digi-switches clockwise.

Recommendation:

The uncertainty of the frequency measurement is equal to the short term stability AVAR(τ) of either the Rb clock or the external reference source. It is therefore necessary to measure during at least 100 s in order to get an uncertainty in the order of ±3E-12.

Chapter

7 Operation

Including :

- Overview
- User Interface
- Main Window
- Setting-Up
- Diagnostics Functions
- Data Acquisition - Measuring with WinSTS
- Measurement Information
- The File System
- The Graph Windows
- Templates (masks)
- Filter Function
- Linear Regression

This page has been intentionally left blank

7.1 Overview

The STS operates in tandem with a PC running the Microsoft Windows 2000 SP4, Windows Server 2003 and Windows XP SP2 operating systems. WinSTS is the front-end of the STS measurement system. WinSTS is a 32-bit multithreaded program and therefore is unable to run under earlier versions of Windows.

For the installation procedure of the WinSTS program, refer to **section 4.2**.

A typical sequence for the operation of the STS looks like this:

- Starting up the WinSTS program.
- Setting up the STS instrument (refer to **section 7.4**)
- Data acquisition (refer to **section 7.6**)
- Visualisation of the acquired data (refer to **section 7.9**)

7.2 User Interface

The WinSTS program employs the standard MS Windows' user interface. The normal method of navigation is by a mouse. If you do not have a mouse, then the keyboard can be used in the following way:

- **[TAB] Key**: Moves the input focus from one interface element to another.
- **[↑] [↓] Keys**: Modify parameters within list boxes and radio button groups.
- **[SPACEBAR] Key**: Set checkboxes and depress buttons.
- **[RETURN] Key**: Validate a command.
- **[ALT-<c>] Key combination**: Select menu items with where <c> is the underscored character of the menu item;
- **[ALT-TAB] Key combination**: Switch between windows.

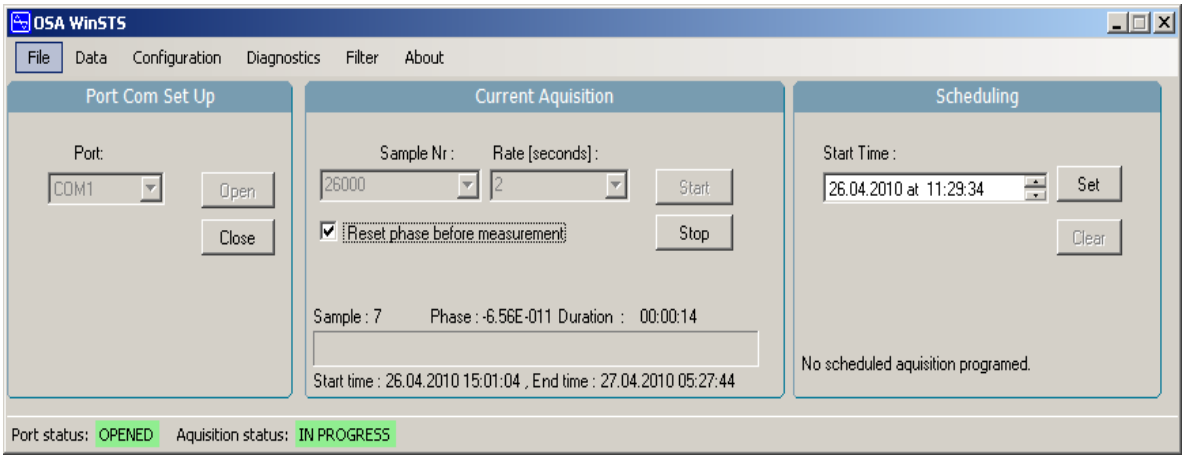
7.3 Main Window

The main window consists of just the controls that are necessary to perform the synchronisation measurement, whilst leaving all the other functionality to be access from the menu bar. In this way the measurement activities are separated from the graphing and set-up functions so that the user is presented with a straightforward and unambiguous user-interface.

The layout of the main is devided into thre area :

Port Com Set Up area: to open and close communication with STS instrument.
Current Acquisition area: to configure, start and stop the aquisition
Scheduling area: to configure an aquisitionnscheduling.
Main menu: to access Data vizualization, configuration, diagnostics and filters functions.
Status bar: to show the port com status and acquisition status.

The layout of the main window is as follows:



Menu Headings:

- **File**: Open and save data files.
- **Data**: View STS data.
- **Filter**: Filters TIE data
- **Configuration**: Options for Setting-up an STS measurement.
- **Diagnostics**: Allows the user to interrogate the STS directly to aid fault-finding etc.
- **Abaout**: About dialog box.

7.3.1 'File' Menu Headings:

Open : Select and open a saved data file from the Windows file system.
Save : Save the current contents of the program's data buffer.
Quit : Exit the program.

Refer to **section 7.8** for further details on STS files.

7.3.2 'Data' Menu Items:

TIE : Display plot of the raw time interval error data.
Ym : Display plot of the mean frequency variation.
MTIE : Display plot of the maximum time interval error.
MADEV : Display plot of the modified Allan deviation.
ADEV : Display plot of the Allan deviation.
TDEV : Display plot of the time deviation.

Refer to **section 7.11** for details about these functions.

7.3.3 'Filter' Menu Items:

Normalize :Starts a linear fit on actual TIE data.
SubSet : Reduce data to un sub set of actual data.
Undo :Undo the last operation on data (subset or Normalization) and return to original data.

Refer to **section 7.12** for details about filter functions.

7.3.4 'Configuration' Menu Items:

User Info

- **->Default**

  For entering default measurement-specific text.

- **->Current Aquisition/File**

  For entering current acquisition or file measurement-specific text.

STS Configuration : Sets-up the STS measurement parameters.

Refer to **section 7.4** for details on configuring the STS.

7.3.5 'Diagnostics' Menu Items:

Current Phase : Displays the current phase in units of 0.1 nanoseconds.
Alarms : Displays the current STS alarm status.
Reset Phase Acc. : Resets the STS phase accumulator to zero.
Status String : Displays the current STS configuration.
STS Firmware Version : Displays the firmware version of the STS phase measurement module.

Refer to **chapter 8** for details about these functions.

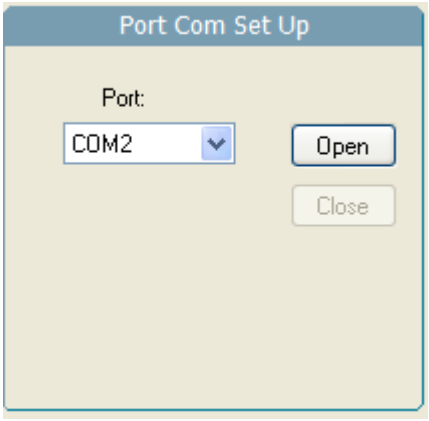
7.3.6 'About' Menu Items:

About: : Displays an "about" dialogue box displaying title and version information of the WinSTS program.

7.4 Setting-Up

7.4.1 RS232 Serial Link

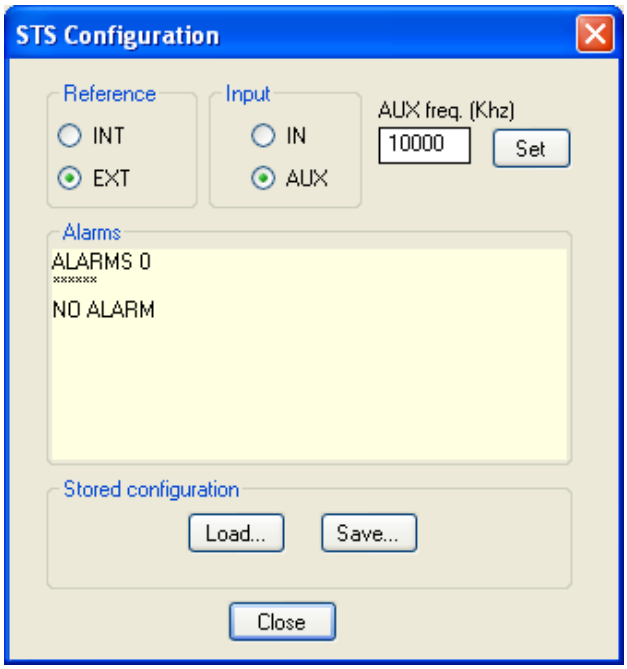
The first thing that requires setting up is the RS232 “NULL MODEM” serial link between the PC and the STS unit.

STEP	ACTION
1	Reach the Port Comms setup area. 
2	Select the port number on which you connected the STS. The value must be in a range of 1 to 99. Of course you should only select the ports that your PC really has. • The program will automatically configure the selected port to the following parameters: Baud rate: 9600 Baud Parity: None Stop bits: 2 Character length: 8 bits

Procedure 7-1 RS232 Serial Link Set-up

7.4.2 Signals Configuration

Next, configure the STS unit according to the signal to be measured.

STEP	ACTION
1	If the port com is closed, click the Open button. The WinSTS program will then establish a connection to the STS unit. The port status will indicates “Opened” on status bar.
2	From the “Configuration” menu select “STS configuration”. The following dialogue box will then retrieves and display the STS unit’s current configuration:  The STS requires three parameters for a measurement: 1. Auxiliary input frequency. 2. Selection of the input connector. 3. Selection of the reference source.
3	When the STS configuration is complete, click on the “Close” button to close the dialogue box.

Procedure 7-2 Signals Configuration

Any changes made to the values will take effect immediately. Therefore at all times the values in the dialogue box are the same as those that the STS has.

The STS will always power-up with the last configuration displayed in this dialogue box.

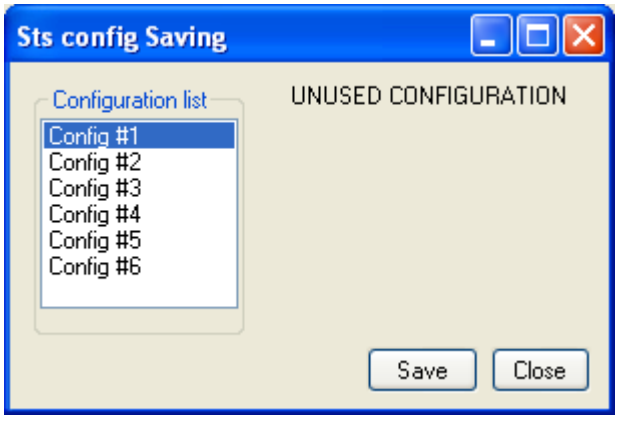
The alarm status is displayed automatically it in the space “Alarms”. The main causes of alarms are that the input/reference signals are either absent or do not match the values that have been set in the dialogue’s controls.

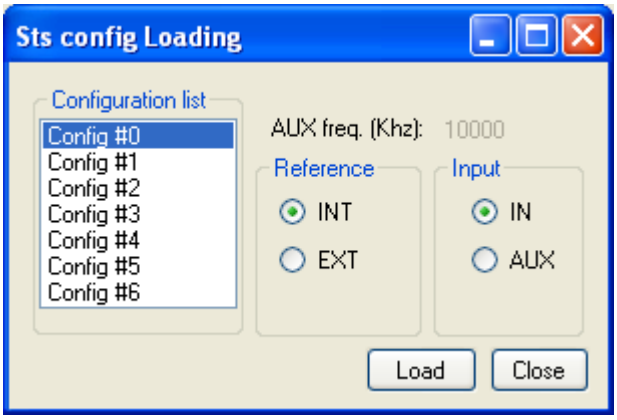
Recommendation:

STS measurement data is invalid if there is an alarm. Always check for alarms before exiting this dialogue box and observe the alarm lamp located on the Phase Measurement Module in the STS unit. For the alarm message ‘y>1E-5’ or ‘no alarm’ with lamp on, there is no measurement error for ΔTIE< 500 ns on 12.5 ms period.

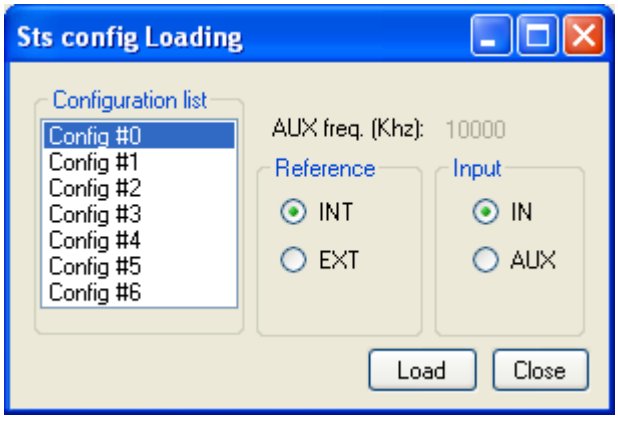
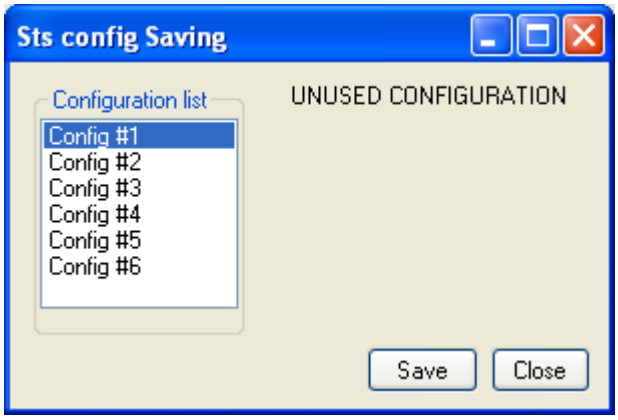
7.4.3 Predefined Signals Configurations

In order to expedite the setting up process, the STS can store predefined configurations in 6 registers - numbered 0 to 6.

STEP	ACTION
1	To save the current configuration (the one set in the “STS Configuration” dialogue box) you have to click the “Save…” button from “STS Configuration” dialogue box. The following image shows the “STS Save current settings” dialogue box:  Config #0 is set at the factory and cannot be used for saving, therefore the “Save” button will be inactive when Config #0 is selected; all the

STEP	ACTION
	others are useable. Clicking on one of the items in the configuration list will cause the selected configuration to be displayed in the box on the right. When a register has never been used before, the dialogue box displays as following: Clicking on the “Save” button will save the current STS configuration settings under the highlighted “Config” number. When the saving successed, the “Save” button becomes inactives until an other configuration register is selected 
2	Clicking on the “Close” button will close the dialogue box.

Procedure 7-3 Saving Current Configuration

STEP	ACTION
1	When clicking the “Load…” button from “STS Configuration” dialogue box, you will be able to set the current configuration to the values of one of the 7 predefined configurations  You can choose a predifined configuration by selecting one of the items in the left list. The content of the selected configuration will be displayed in the box on the right. Clicking on the “Load” button will load the selected predefined configuration and define it as the current configuration. The dialogue box will automatically close if the loading success. When a register has never been used before, the dialogue box displays as following:  The ”Load” button will be inactive.
2	Clicking on the “Close” button will close the dialogue box.

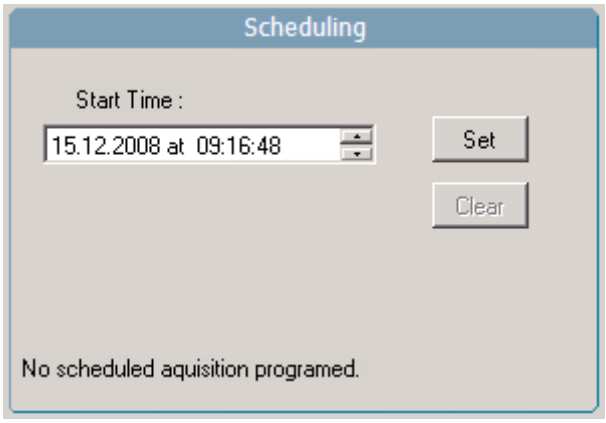
Procedure 7-4 Loading Predefined Configuration

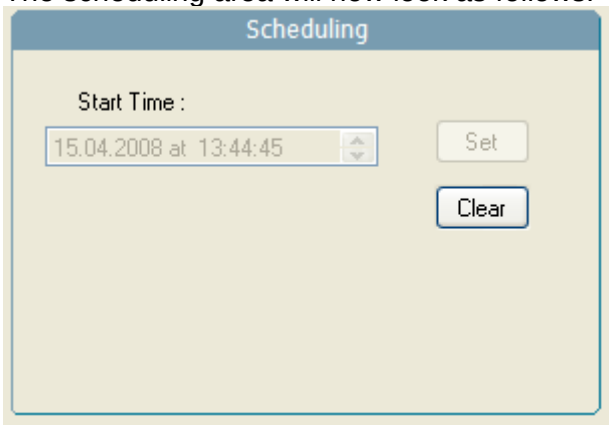
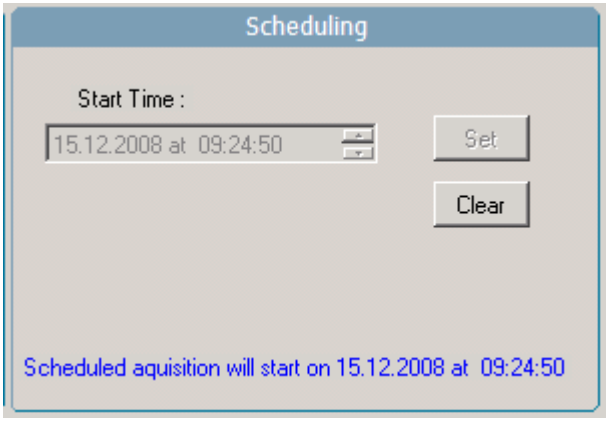
Note:

All settings and preferences made are automatically saved when the application is closed down. STS settings are stored onboard in non-volatile RAM, whilst program settings are stored in a temp initialisation file. The initialisation file is automatically created by the program.

7.4.4 Scheduling an Aquisition

This function allows scheduling an aquisition.

STEP	ACTION
1	When scheduling an acquisition, reach the scheduling area  Choose the date and the time of the aquisition. A scheduled date defined in the past will display an error message.
2	Click on “Set” button to activate the schedule.

STEP	ACTION
3	The scheduling area will now look as follows:  The acquisition will start at the programmed schedule.
4	The scheduled aquistion time is now configured :  To disable a scheduled acquisition, press Clear button.

Procedure 7-5 Squeduling an aquisition

7.5 Diagnostics Functions

The diagnostics functions, accessible via the ‘Diagnostics’ menu on the main window, are designed to set up the STS and for fault finding. The following STS functions are available:

- Current Phase (in units of 0.1nanoseconds).
- Alarm status.
- Resetting of the phase accumulator to zero.
- Current STS configuration.
- Firmware version number of the STS phase measurement module.

Clicking on one of the menu items will bring up a dialogue box with a “Refresh” and “Close” button. Pressing “Refresh” causes the relevant STS command to be sent to the STS and the reply from the STS is displayed directly to the dialogue box’s message area.

Note: In the case of ‘Current Phase’, the phase accumulator inside the STS is only able to hold a maximum phase value of ±100 microseconds (±1000000 × 1.0e-10 seconds). After this value the phase accumulator “wraps around” to actual TIE ± 100 µs near zero. In the normal course of operation the WinSTS program, which keeps it’s own “virtual” phase accumulator, compensates for this effect. Therefore, the value of the phase obtained via the diagnosis function may not agree with the values shown during a proper measurement.

For further information and a full list of STS commands, refer to **chapter 8**.

7.6 Data Acquisition - Measuring with WinSTS

Once the WinSTS program has been started and the STS has been set up properly, you can start measuring. A typical measurement session has the following phases:

- Data acquisition.
- Visualisation of the acquired data.
- Calculation of statistical functions.

Once the STS has been set up (refer to **section 7.4**), the measuring procedure is as follows:

STEP	ACTION
1	Enter or select the number of samples that are required in the “Sample” edit box.
2	Enter or select the frequency at which you wish the readings to occur in the “Rate” list box.
3	Click on the “Start” button.

Procedure 7-6 Data Acquisition - Measurement

The measurement progress bar will then show the measurement duration. The value and number of each reading is displayed at the bottom of the screen on the message bar. The start time and the estimated end time are also shown The measurement may be aborted at any time by clicking on the “Stop” button.

Any graph windows that are open will be updated regularly with the new readings. Note though; if there are a large number of graph windows open the update rate will slow appreciably, particularly on slower machines.

The different functions are processed in the following order:

- TIE
- Ym
- ADEV
- MADEV
- TDEV
- MTIE

***Note*:**

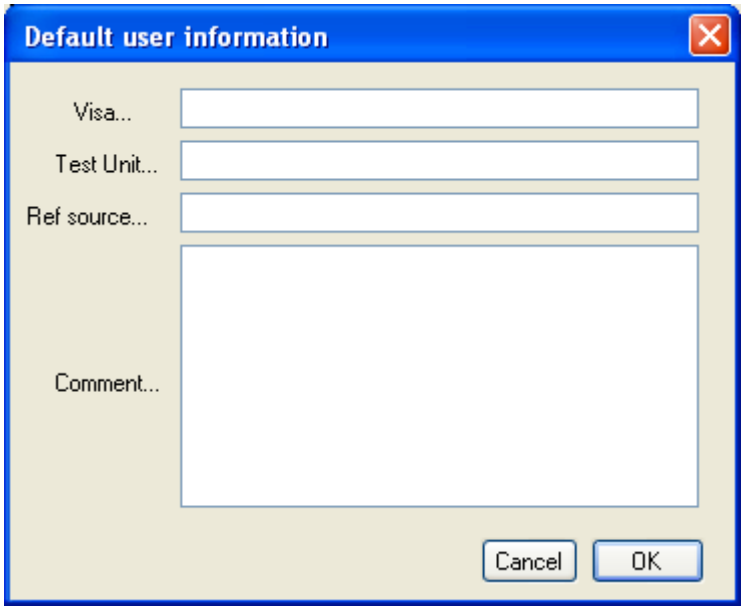
The MTIE full points calculation can take time depending of the number of samples and the values of measurement.

7.7 Measurement Information

Useful information about the measurement can be entered into the program via the "Default User Info" dialogue box and the ‘Acquisition/File User Info’ dialogue box which are accessible from the main menu:

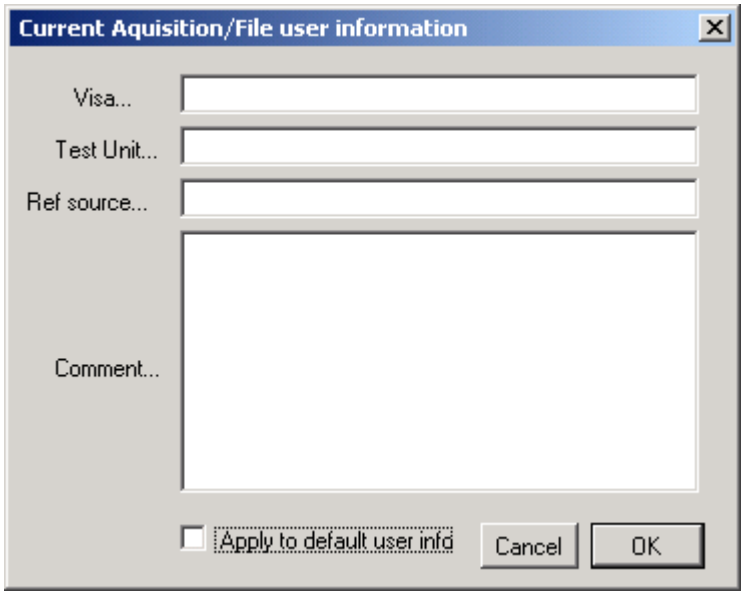
7.7.1 "Default User Info" dialogue box

The ‘Default User Info’ dialogue box allows defining the User Info parameters that will be used for each new acquisition..



7.7.2 "Acquisition/File User Info" dialogue box

The 'Acquisition/File User Info' dialogue box allows defining or modifying the User Info parameters for the current acquisition or opened file. The entered text can be displayed and printed by every graph window (refer to **section 7.9**). These parameters are saved to disc in the TIE measurement file.
You can copy the parameters to the Default User Info by marking the 'Apply to default User Info' check box.



7.8 The File System

7.8.1 Measurement Data Files

During aquisition, WinSTS saves the data to a temporary binary file. This temporary file is deleted once the user has either saved or cancelled the acquisition to a TIE file. The presence of the temporary file will make the application ask if the current acquisition has to be saved or not. The presence of the temporary file is checked at start-up, when starting a new acquisition and when closing the application. The start-up check allows to recover the aquisition data after an unvolontary shut-down or a crash of the computer.

The file format is in ACSII and an information structure has been added before the data list.

- The first line informs about the file structure version.
- The second line gives the number of header lines that follow.
- The header lines contain the User Info data.
- The line following the header lines gives the number of acquisition points.
- Then follow the acquisition data in the following format:
- [Time(seconds)] <TAB> [Phase value]<CR><LF>

Here is an example of a ten points acquisition file:

WINSTSFILEVERSION=2000<CR><LF>
HeaderLines=6<CR><LF>
Aqui_Info_MeasurementState=10 x 12.5 milliseconds on 29.09.00
16:35:54<CR><LF>
Aqui_Info_Filename=Test_10_corriger.TIE<CR><LF>
Aqui_Info_Comments=DefaultComments<CR><LF>
Aqui_Info_MeasureRef=DefaultReference<CR><LF>
Aqui_Info_SignalTest=DefaultTest<CR><LF>
Aqui_Info_Visa=DefaultVisa<CR><LF>
AquisitionPoints=10<CR><LF>
0.0125<TAB>-1.00E-10<CR><LF>
0.025<TAB>1.00E-10
0.0375<TAB>-1.00E-10<CR><LF>
0.05<TAB>-1.00E-10
0.0625<TAB>-1.00E-10<CR><LF>
0.075<TAB>-1.00E-10
0.0875<TAB>-1.00E-10<CR><LF>
0.1<TAB>-1.00E-10
0.1125<TAB>-1.00E-10<CR><LF>

0.125<TAB>-1.00E-10<CR><LF>

By default the data files are stored with “TIE” extensions (Time Interval Error), though the user is free to choose their own extension if desired.

7.8.2 WinSTS V3.00 Measurement Data Files

WinSTS 3.XX is able to read TIE file formats of version 2.2x. It will also display the User Info data.

7.8.3 Template Files

Template or mask files (refer to **section 7.10** on templates) are also in ASCII format and differ from the TIE data format in that they have no information structure before the template data.

Template files can either be created using the “Plot-to-template” graph window function (section 7.9), or created by the user directly from the software or with the aid of a simple text editor. Note though, that the last line in the file does not require the carriage return - line feed characters.
A set of normalised templates is delivered with the application. See the Application Note for more details about these templates.

7.9 The Graph Windows

The graphing windows (see example below) display graphs of the STS TIE and statistical data based on the TIE readings. The windows are resizeable and have the ability to be printed out or copied to the Windows clipboard for pasting into other Windows applications.
There is a graph window for each function. Although there can be any number of windows open simultaneously, there can only be one window to each function. Clicking on one of the items in the “Data” menu on the main window will either create and display graph window or, if it already exists, will bring the selected window to the top of the Windows desk top.

Figure 7-1 : WinSTS Graph Window Example

The graph window displays at least the data of the current acquisition or open file in regard to the function. But it can also display template. The function data and the template data are displayed in different colors and/or different line patterns. Each serie is listed in a legend above the graph area with its name, its color and its line pattern. The adjustments for the series are discussed in section 7.9.3.

7.9.1 The Graph Screen Menu Bar

7.9.1.1 Menu Headings

- **Window** : Window controls for printing and copying.
- **Show** : Controls the amount of text information shown on the window.
- **Fonts** : Sets the font attributes for the text displayed on graph axis.
- **Attributes** : For adjusting the properties of the graph.

7.9.1.2 "Window" Menu Items

- **Print Preview** : Opens the Print preview dialogue box. This window allows printer selection, printer setup and margins adjustments.
- **Print** Print the graph window
- **Copy to clipboard** : Copies the contents of the client area to the Windows clipboard (in meta-file format) for pasting to other Windows applications.
- **Copy as** Copies the image client area in the selected format (bmp, jpg, emf , wmf, gif, png, tiff, or pdf): The default format is png.
- **Plot-to-template** : Saves the displayed data points in a template file. Refer to **section 7.10**.
- **Show data** Presents to the user a grid view of displayed data.
- **Close** : Closes the graph window.

7.9.1.3 "Show" Menu Items

- **Grid Lines** : Displays graph with grid lines.
- **Templates** : Displays loaded templates.
- **Title** : Displays the title of the graph.
- **Axis Labels** : Displays the graph axis labels.
- **File Name** : Displays the name of the current file.
- **Measurement States** : Displays date/time and number of readings.
- **Visa** : Displays the user's name.
- **Test Signal/Unit** : Displays the test signal text.
- **Reference Signal** : Displays the reference signal text.
- **User Comments** : Displays the user comments text.

Only for TIE and Ym window :

- **Linear regression line** : Displays regression parameters and line.

Only for TDEV wndow

- **Limite of validity** : Displays “tau” limit of validity.

7.9.1.4 "Fonts" Menu Items

- **X title** : Configuration of the x axis title font.
- **Y title** : Configuration of the y axis title font.
- **X labels** : Configuration of the x axis labels font.
- **Y labels** : Configuration of the y axis labels font.

7.9.1.5 "Attributes" Menu Items

- **Header/Footer** : Opens the graph header/footer editor dialogue box.
- **Axes** : Opens the axes properties editor dialog box (section 7.9.3).
- **Series** : Opens the series editor dialog box (section 7.9.5).
- **Templates** : Opens the template management dialogue box.

7.9.2 The Contextual menu

7.9.2.1 Menu items

- **Show data** : Shows a data grid view of data currently displayed
- **Axes** : Opens the axes properties editor dialog box (section 7.9.3).
- **Series** : Opens the series editor dialog box (section 7.9.5).
- **Templates** : Opens the template management dialogue box.

7.9.3 Axes

The axes properties dialog box can be accessed from the graph window's 'Attributes-Axes' menu item or from contextual menu:

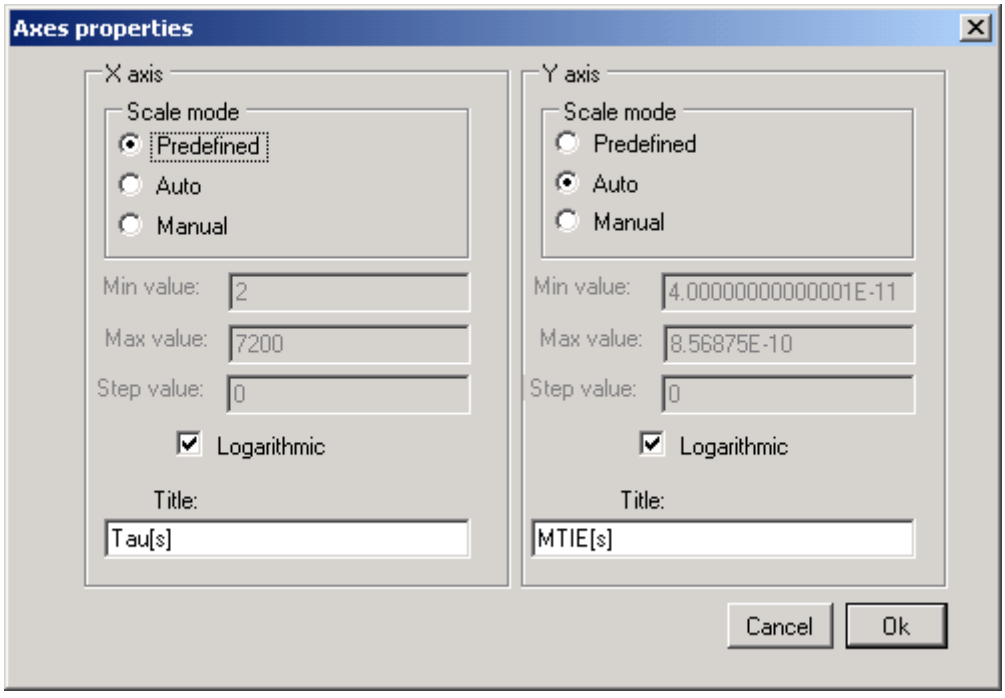


Figure 7-1 : Axes Properties - Dialog Box

Both the x and y axis require lower ('Min value') and upper ('Max value') boundary values. The 'Step' value is the size of the spacing between ordinals.

Predefined Mode: In predefined mode, min values and max values are calculated by the program based on the lower and upper data allowing to reduce the need of zooming. The step is in terms of the 'Max' and 'Min' values.

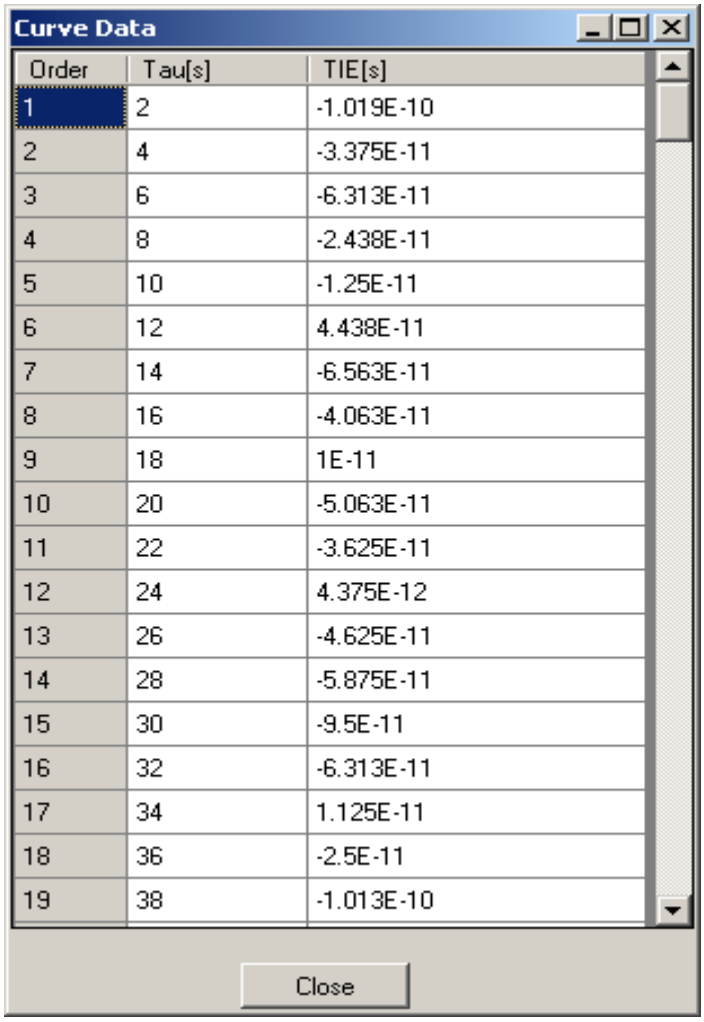
Auto Mode: In auto mode, min values and max values are self calculated. The step is in terms of the 'Max' and 'Min' values.

Manual Mode: In manual mode min values, max values and step are entered by the user.
Each axis can be set into logarithmic or linear scale (Except Y values for TIE And YM graph where only linear scale is available).

The dialog box offers also the possibility to change the title of each axis.

7.9.4 Show data

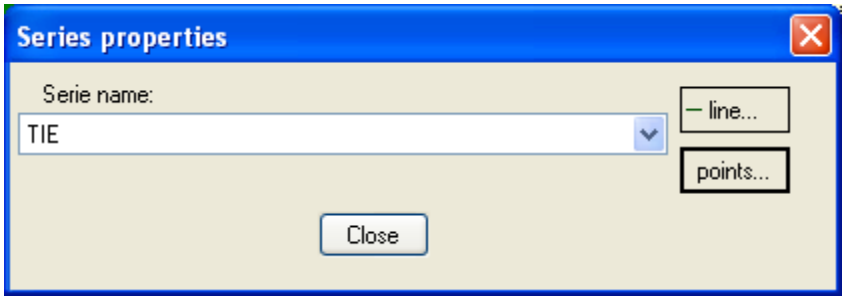
The current data grid view can be accessed from the graph window's 'Window-Show data' menu item or from contextual menu:



Order	Tau[s]	TIE[s]
1	2	-1.019E-10
2	4	-3.375E-11
3	6	-6.313E-11
4	8	-2.438E-11
5	10	-1.25E-11
6	12	4.438E-11
7	14	-6.563E-11
8	16	-4.063E-11
9	18	1E-11
10	20	-5.063E-11
11	22	-3.625E-11
12	24	4.375E-12
13	26	-4.625E-11
14	28	-5.875E-11
15	30	-9.5E-11
16	32	-6.313E-11
17	34	1.125E-11
18	36	-2.5E-11
19	38	-1.013E-10

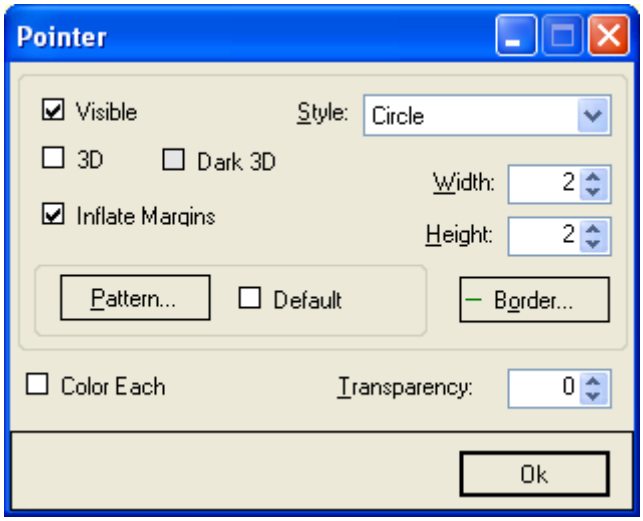
7.9.5 Series

The series properties dialog box can be accessed from the graph window's 'Series' menu item:



Select the desired serie and set its properties as follow:

To set line properties click on line button to open Border editor.



To set pont properties, click points button to open pointer editor

7.9.6 Zooming

7.9.6.1 Zoom IN

You can zoom into the graph simply by selecting a rectangle on the graph.
The rectangle is defined from the upper left corner to the lower right corner while holding the left mouse button down. During mouse move a white rectangle is drawn to visualise the selection. If You do not move from left to right and from top to bottom, the zoom will not be displayed.
This function works only when the graph isn't in progress

Figure 7-2 : Zoom IN on Graphs

Once the zoomed part is displayed, You can even zoom further by selecting again a zone.

7.9.6.2 Zoom OUT

To come back to the full curve display, simply select a rectangle where the release corner does not end under and right of the starting corner.
The following view shows the different possibilities to zoom back to the full curve.

Figure 7-3 : Zoom OUT on Graphs

7.9.7 Number of Data Points (TIE and Ym only)

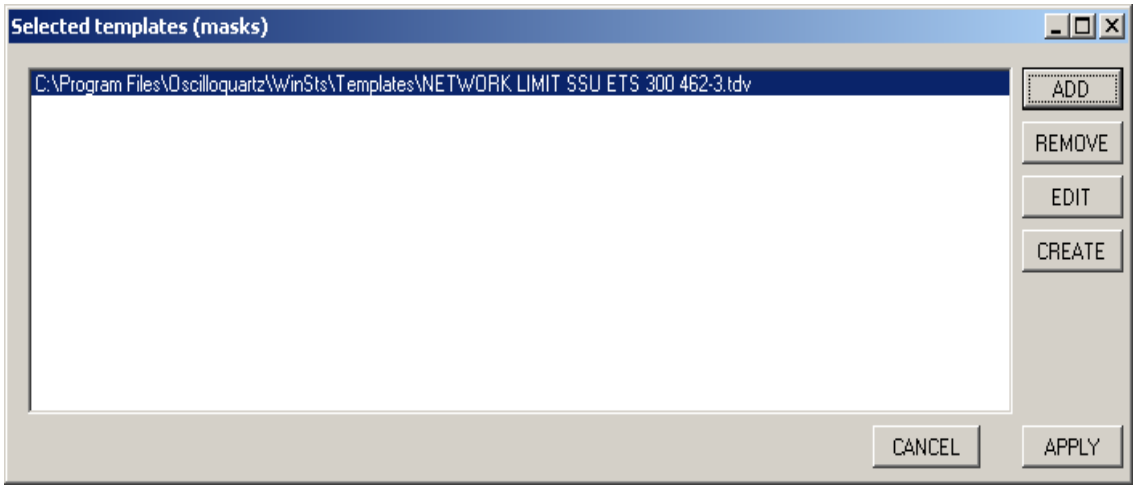
This edit control sets the limit to the number of points that are drawn on the graph. This is necessary for two reasons. One, a graph that has thousands of points is not particularly clear; and two, drawing thousands of points takes a great deal of processing time. For printouts and final analysis, there is a check-box to override this filtering function if desired.

7.10 Templates (masks)

The graph windows are able to display templates data (or masks). Templates are stored as separate ASCII files, which can be created either by using the “Plot-to-template” graph window function, or by the user directly from management software or with the aid of a simple text editor. Refer to **section 7.8** on file formats. Template files can have long file names so that they are more descriptive.

Templates differ from measurement data in one important aspect - the points are not mathematically processed before they are plotted. For example, the point X=1000.0, Y=1.42e-10 will be plotted at that co-ordinate regardless of whether the graph is of TIE, MTIE or ADEV etc..

Templates are managed via the ‘User Graph Templates’ dialogue box:



- To add a template plot to the current graph, hit the ‘ADD ’ button.
- To remove a template, click on it’s name in the list box and hit ‘REMOVE’ button.
- To Edit a templete, click on it’s name in the list box and hit ‘EDIT’ button.
- To create a new template, hit ‘CREATE’ button.

Each graph window has it’s own template management i.e. the TIE window has TIE templates, the TDEV window has TDEV templates etc. The plotting of templates can either be enabled or suppressed via the ‘Show/Templates’ graph window menu item.

A set of normalised templates is delivered with the application. See the Application Note, part 11, for more details about these templates.

7.11 Statistical Functions

7.11.1 MTIE Analysis:

τ_0 : Sample Period $[s]$

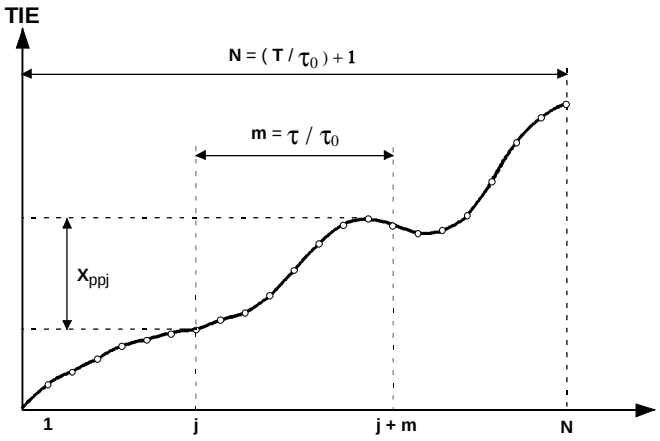
$\tau = m\tau_0$: Observation Time

T : Measurement Period $[s]$

$T = (N-1)\tau_0$

$X_i = \{X_1, X_2, \ldots, X_N\}$

N Time Delay samples $[s]$



X_{ppj} = Peak - to - Peak X_i within **jth** observation

$MTIE(\tau)$ = maximum X_{ppj} for all observation of lenght τ within **T**

$$MTIE(\tau) = \max_{j=1}^{N-m+1} \left[\max_{i=j}^{m+j-1}(X_i) - \min_{i=j}^{m+j-1}(X_i) \right]$$

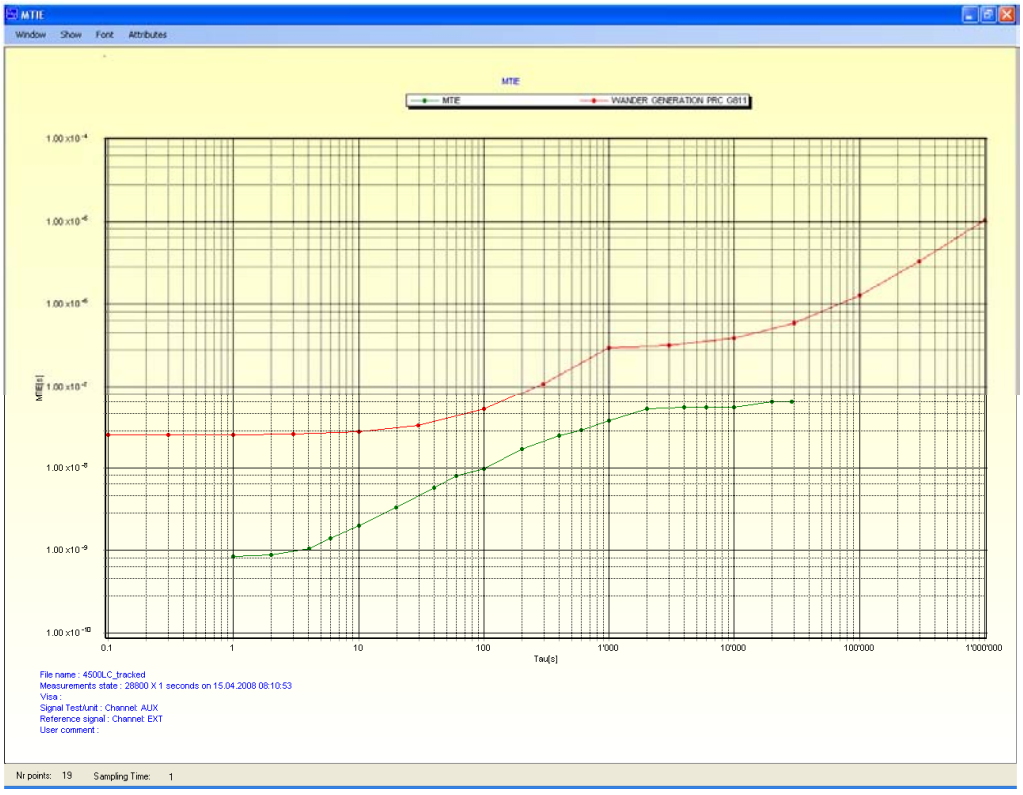
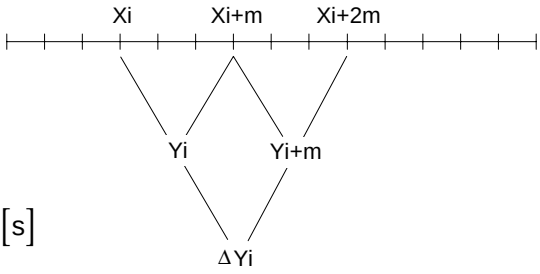


Figure 7-4 : MTIE White Phase Noise Simulation

7.11.2 ADEV Analysis:



τ_0 : Sample Period $[s]$

$\tau = m\tau_0$: Observation Time

T : Measurement Period $[s]$ = $(N-1)\tau_0$

$X_i = \{X_1, X_2, \ldots, X_N\}$, N Time Delay samples $[s]$

$$AVAR(m\tau_0) = \frac{1}{2(N-2m)(m\tau_0)^2} \sum_{i=1}^{N-2m} (\Delta Y_i)^2 \quad \text{where } \Delta Y_i = Y_{i+m} - Y_i = X_{i+2m} - 2X_{i+m} + X_i$$

$$ADEV(m\tau_0) = \sqrt{\frac{1}{2(N-2m)(m\tau_0)^2} \sum_{i=1}^{N-2m} (X_{i+2m} - 2X_{i+m} + X_i)^2}$$

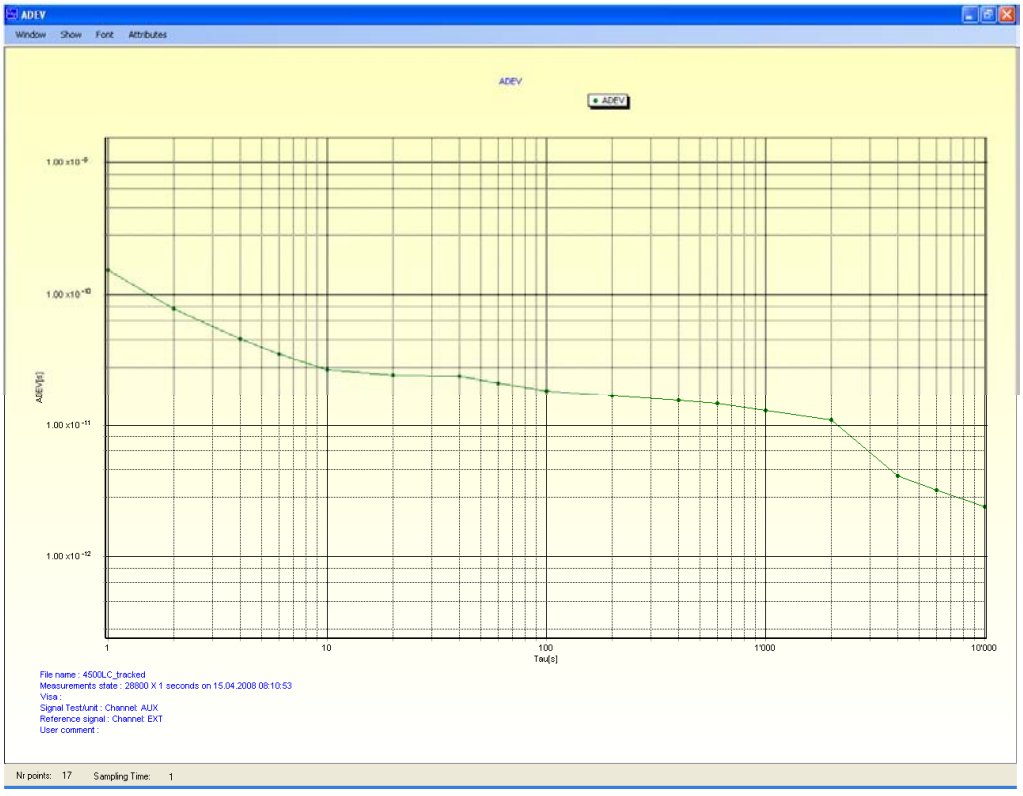
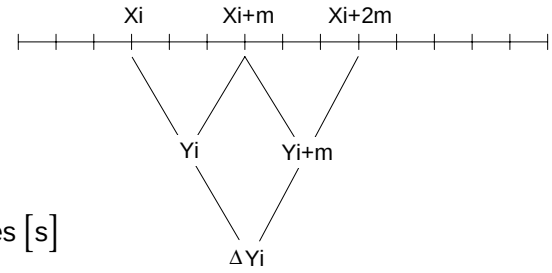


Figure 7-5 : ADEV White Phase Noise Simulation

7.11.3 MADEV & TDEV Analysis:



τ_0 : Sample Period $[s]$

$\tau = m\tau_0$: Observation Time

T : Measurement Period $[s]$ = $(N-1)\tau_0$

$X_i = \{X_1, X_2, \ldots, X_N\}$, N Time Delay samples $[s]$

$$MAVAR(m\tau_0) = \frac{1}{2(N-3m+1)(m\tau_0)^2} \sum_{j=0}^{N-3m} \left[\frac{1}{m} A_j\right]^2 \quad \text{where} \quad A_j = \sum_{i=1}^{m} \Delta Y_{i+j}$$

$$MAVAR(m\tau_0) = \frac{1}{2m^2(N-3m+1)(m\tau_0)^2} \sum_{j=0}^{N-3m} \left[\sum_{i=1}^{m} (X_{i+2m+j} - 2X_{i+m+j} + X_{i+j})\right]^2$$

$$MADEV(m\tau_0) = \sqrt{MVAR} \qquad TDEV(m\tau_0) = \sqrt{\frac{(m\tau_0)^2}{3} MVAR}$$

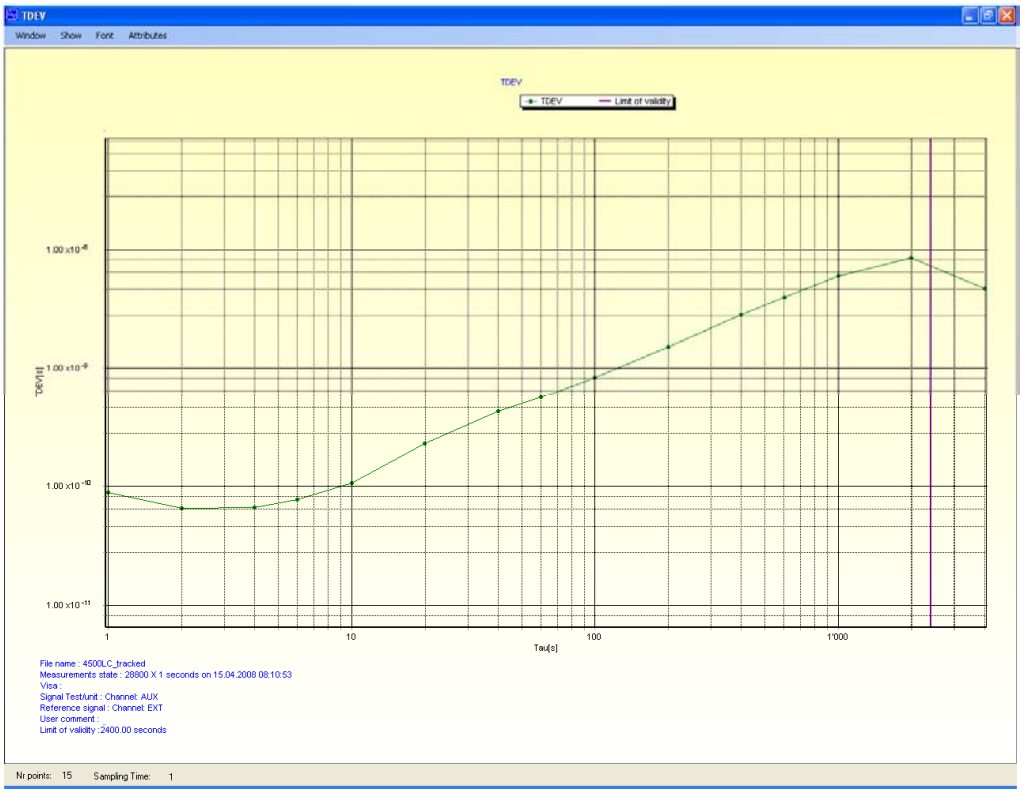


Figure 7-6 : TDEV White Phase Noise Simulation

7.12 Filter Function

7.12.1 Averaging Ym data

The averaging function is accessible on Ym graph window. Put the averaging weight and click refresh button to take into account the new average weight. The value of default averaging weight is 10.
This function computes the exponential mean with a time constant of:

*Tau = averaging weight * sampling time of TIE*

This mean correspond to a low pass RC filter with –3 db bandwidth at $f_c = 1/(2\pi Tau)$.

The averaging weight is always displayed in the Ym data Window

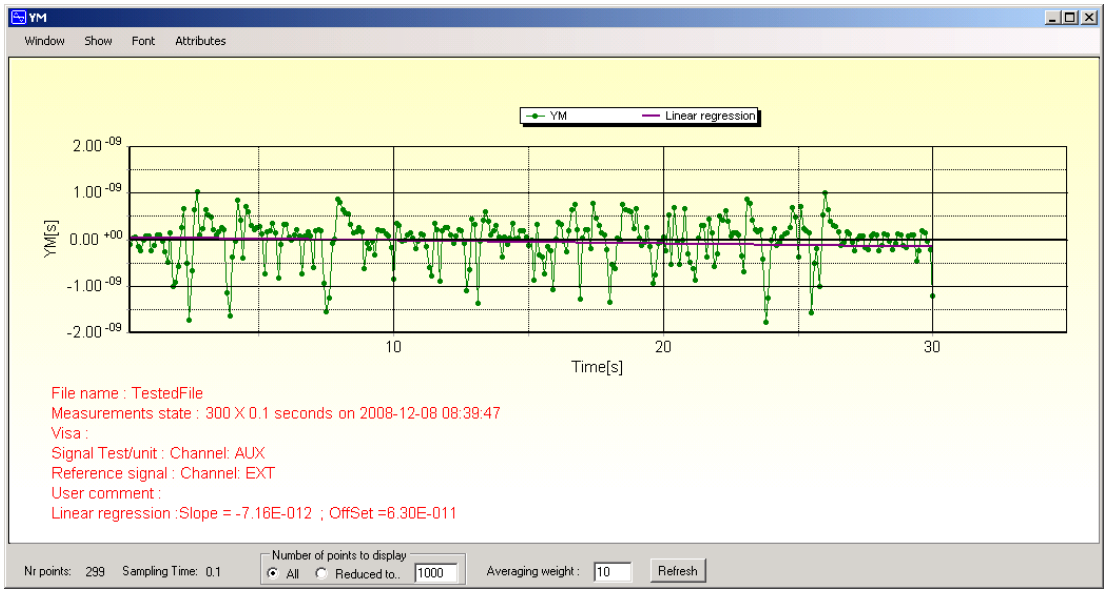
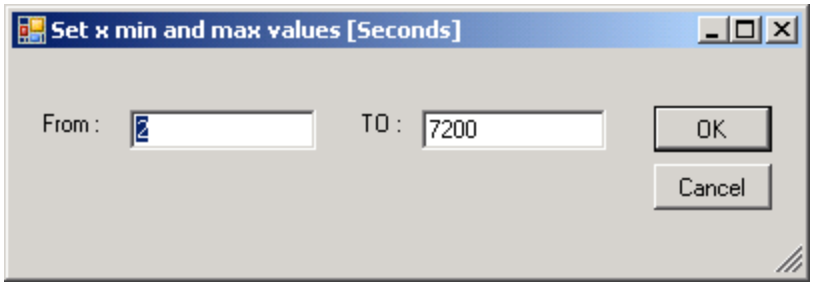


Figure 7-7 : Ym Data Averaging Simulation

7.12.2 Sub-Set

The Main window allows selecting a sub-set of the actual displayed acquisition. This can be done with a new aquisition or from a file loaded acquisition.

Selct the main menu <Filters> and choose the item <Sub-Set>. The sub set configuration window is opened.



As long as the subset has not been disabled, all actions , graphs and functions (YM,TIE, MTIE, TDEV, ADEV, MADEV) are reported to the selected subset .
To go back to original data use Undo command.

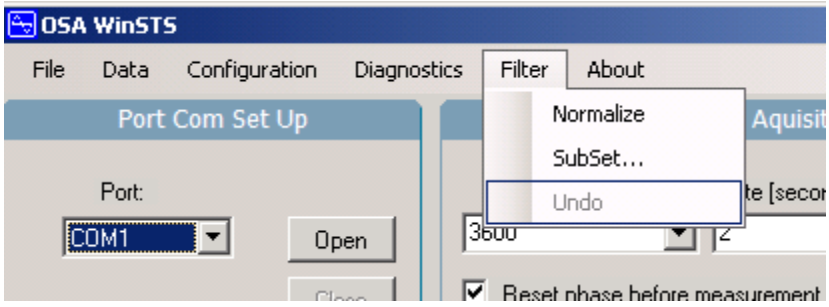
7.12.3 Undo Sub-Set/Normalization

The main menu <Filters> offers the item < Undo>. To disable normalization and subset functions.

7.12.4 Normalize TIE data

The main menu <Filters> offers the item < Normalize TIE data>. This function gives the possibility to remove a constant frequency offset and initial TIE from the TIE data.

The normalization can be done in cascade.



The new TIE data correspond to:

$$\hat{x}_k = x_k - (a * t_k + b)$$

where $\hat{x}_k$: new TIE at time $t_k = K * \tau_o$ $K \in \{1..n\}$

x_k : measured TIE at $t_k = K * \tau_o$

τ_o : sampling time (rate)

a : constant frequency offset

$$a = \frac{n \sum (x_k * t_k) - \sum t_k * \sum x_k}{n \sum t_k^2 - (\sum t_k)^2}$$

b : initial TIE

$$b = \frac{\sum t_k^2 \sum x_k - \sum (x_k * t_k) \sum t_k}{n \sum t_k^2 - (\sum t_k)^2}$$

7.13 Linear Regression

7.13.1 TIE Linear Regression

The linear regression parameters and the graphical representation (straight line) is automatically displayed in the “TIE graph” window if the “Linear regression line” menu item is tagged in the “Show” menu.

Figure 7-8 : TIE Linear Regression Example

Determination of the linear regression line for a number of adjacent points:

Abscis of 1st point of mesure: Ts = sampling time
Abscis of 1st point selected : T1
Abscis of last point selected: T2
Index of last point measured: n_max

Index of first point : Idx1 = (T1/Ts) -1 if T1 >Ts otherwise Idx1 = 0;
Index of last point: Idx2 = (T2/Ts) - 1 if T2 < Tmax otherwise Idx2 = n_max
Number of points: np = Idx2 - Idx1 - 1

Determination of the sums:

$$Sy = \sum_{i=0}^{np-1} Y[i + Idx1]$$

$$Sxy = \sum_{i=0}^{np-1} i * Y[i + Idx1]$$

Determination of slope and offset:

$$kY = \frac{6 * Sxy - 3 * (np - 1) * Sy}{np * (np - 1)}$$

$$\text{First point : } x1 = T1 \ ; \ \ y1 = \frac{Sy}{np} + kY$$

$$\text{Last point : } x2 = T2 \ ; \ \ y1 = \frac{Sy}{np} - kY$$

$$Slope = \frac{2 * kY}{Ts * (np - 1)} = \frac{12 * Sxy - 6 * (np - 1 * Sy)}{Ts * np * (np^2 - 1)}$$

$$Offset = y1 - slope * (Idx1 + 1) * Ts$$

7.13.2 Ym Linear Regression

The linear regression parameters and the graphical representation (straight line) is automatically displayed in the “Ym graph” window, as well as the daily ageing if the “Linear regression line” menu item is tagged in the “Show” menu.

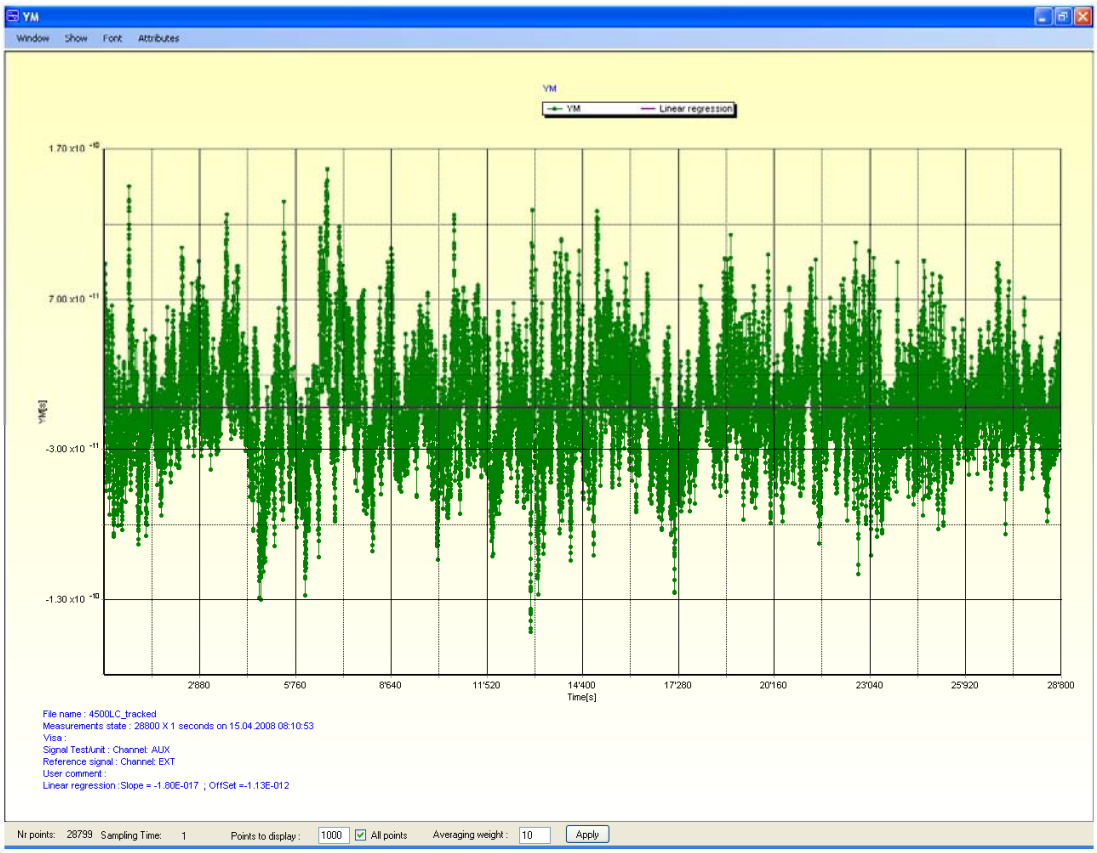

YM
Window Show Font Attributes
YM
YM Linear regression
1.70 x10 -10
7.00 x10 -11
-3.00 x10 -11
-1.30 x10 -10
YM[s]
2'880 5'760 8'640 11'520 14'400 17'280 20'160 23'040 25'920 28'800
Time[s]
File name : 4500LC_tracked
Measurements state : 28800 X 1 seconds on 15.04.2008 08:10:53
Visa :
Signal Test/Unit : Channel: AUX
Reference signal : Channel: EXT
User comment :
Linear regression :Slope = -1.80E-017 ; OffSet =-1.13E-012
Nr points: 28799 Sampling Time: 1 Points to display : 1000 All points Averaging weight : 10 Apply

Figure 7-9 : YM Linear Regression Example

Determination of the linear regression line for difference of a number of adjacent points:

Abscissa of 1st point of measure: Ts = sampling time
Abscissa of 1st point selected : T1
Abscissa of last point selected: T2
Index of last point measured: n_max

Index of first point : Idx1 = (T1/Ts) -1 if T1 >Ts otherwise Idx1 = 0;
Index of last point: Idx2 = (T2/Ts) – 1 if T2 < Tmax otherwise Idx2 = n_max
Number of points: np = Idx2 - Idx1 - 1

Determination of the sums:

$$Sy = \sum_{i=0}^{np-1} Y[i + Idx1]$$

$$Sdy = Y[Idx2] - Y[Idx1]$$
$$Sxdy = np * Y[Idx2] - Sy$$

Determination of slope and offset:

$$kdY = \frac{6 * Sxdy - 3 * np * Sdy}{np * (np - 1)}$$

$$\text{First point : } x1 = T1 + Ts \;;\; y1 = \left(\frac{Sdy}{np - 1} - kdY \right) * \frac{1}{Ts}$$

$$\text{Last point : } x2 = T2 \;;\; y2 = \left(\frac{Sdy}{np - 1} + kdY \right) * \frac{1}{Ts}$$

$$Slope = \frac{2 * kdY}{Ts^2 * (np - 2)} = \frac{12 * Sxdy - 6 * np * Sy}{Ts * np * (np - 1) * (np - 2)}$$

$$Offset = y1 - slope * (Idx1 + 2) * Ts$$

$$Daily\ ageing = slope * 86400$$

This page has been intentionally left blank

Chapter

8 STS COMMS Command Set

Including :

- Commande List
- The Diagnostics menu

This page has been intentionally left blank

8.1 Commande List

Below is the list of commands that the STS accepts. To communicate with the STS without using WINSTS.EXE, use a terminal program (such as Windows TERMINAL.EXE) and set the communications port attributes to: 9600 baud, 2 stop-bits, no parity and 8 data bits.

ALARM : State of alarms.
CLEAR : Reset phase accumulator.
COM=b,d,s,p : Set communication parameters.
b = baud rate. Either 1200, 2400, 4800, 9600.
d = data bits/char - 7 or 8.
s = stop bits - 1 or 2.
p = parity - 0 (none), 1 (odd), 2 (even).
CONFx : Parameters of configuration (x = 0 to 7).
CONF=x : Set parameters of configuration (x = 0 to 7).

FAUX : Frequency of AUX input.
FAUX=xxxx : Set frequency of AUX input (64 to 16384 kHz).
FIN : Frequency of IN input.
FIN=xxxx : Set frequency of IN input (64 to 16384 kHz).
HELP : List of commands.
INPUT=IN : Set input channel IN.
INPUT=AUX : Set input channel AUX.
REF=INT : Set ref. channel internal.
REF=EXT : Set ref. channel external.
REV : Software revision number.
SAVEx : Save configuration (x=1 to 7).
START : Transmits continuous measurements in ASCII-HEX at 12.5ms.
STATUS : Configuration of STS.
STOP : End of continuous measurements.
UNIT : Unit of measurements.
XI : Actual phase in decimal units.

Under normal circumstances communicating to the STS in this way isn't necessary because all of the functions are encompassed by WINSTS.EXE.

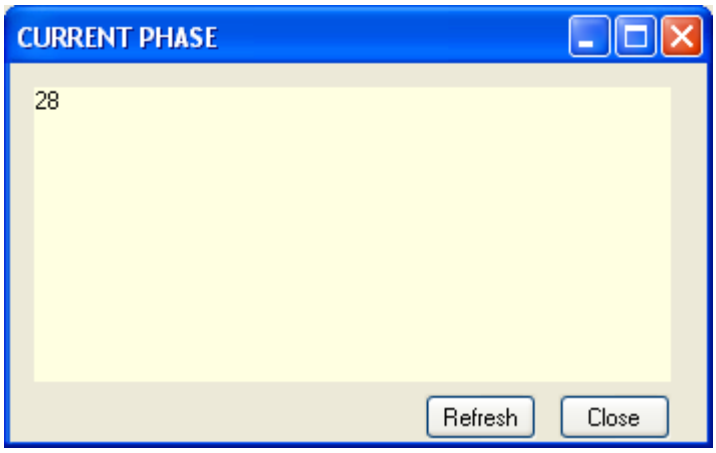
Note: The STS communications port parameters must be set at 9600 baud, 2 stop-bits, no parity and 8 data bits; otherwise WinSTS.EXE will not be able to communicate with it.

8.2 The Diagnostics menu

The Diagnostics menu provides the following menu items:

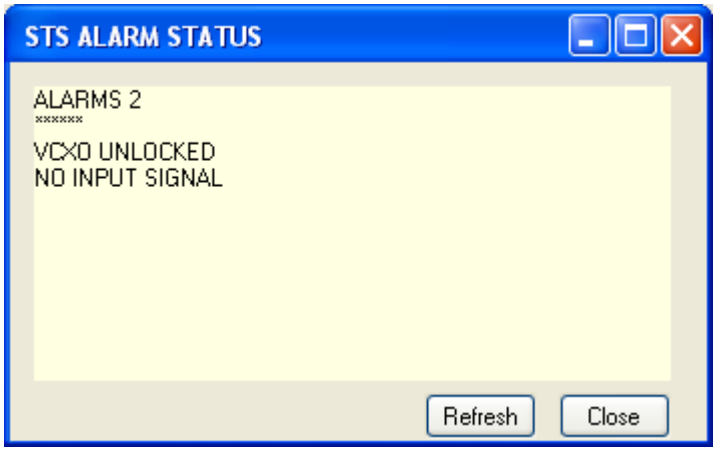
8.2.1 Current Phase

Shows the current phase state of the connected STS equipment. Each “Refresh” button hit will show a new phase value.



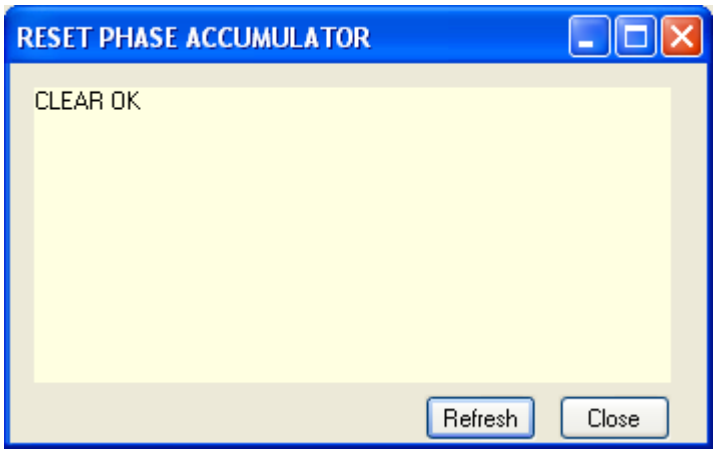
8.2.2 Alarms

Shows the current alarm state of the connected STS equipment. Each “Refresh” button hit will refresh the alarm state.



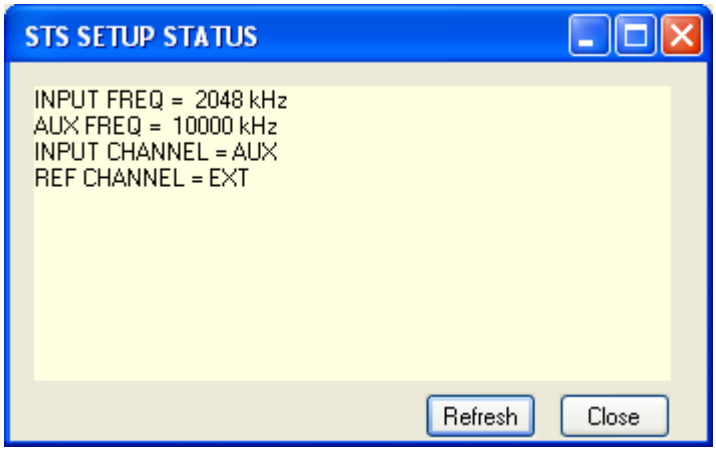
8.2.3 Reset Phase Acc

Shows the following dialog box, which allows resetting the Phase accumulator of the connected STS equipment. You must hit the Refresh button in order to reset the Phase accumulator :



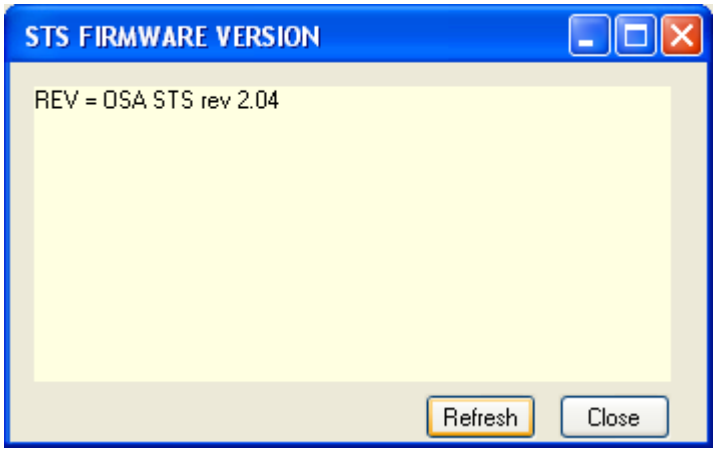
8.2.4 Status String

Shows the current STS Setup Status state of the connected STS equipment.



8.2.5 STS Firmware Version

Shows the current STS Firmware version of the connected STS equipment.



Chapter

9 Preventive Maintenance & Troubleshooting

Including :

- Preventive Maintenance
- Troubleshooting

This page has been intentionally left blank

9.1 Preventive Maintenance

The following preventive maintenance is needed to ensure correct, long life operation of the equipment:

- • Adjustment of the Rb clock: please refer to **chapter 6**
- • Lamp Test: Hold down the toggle switch on the ALARM module (A7) in the

  '**Lamp Test**' position - all LEDs should light up.

  This ensures that all LEDs are working and that all alarms are displayed correctly.

9.2 Troubleshooting

In case of performance degradation such as output level, phase noise, stability, etc., or module failure, simply replace the faulty module with a spare. Please refer to **chapter 5** for a description of the visual alarm indicators.
Due to the modular architecture of the STS this can be done easily without any special restrictions. It is not necessary to switch off the power supply during the replacement procedure. No adjustments other than the ones described in chapter 5 are needed after a module has been replaced.

9.3 Oscilloquartz Contact Information

9.3.1 Technical Assistance

For technical assistance, contact the following:

9.3.1.1 International

Oscilloquartz SA
Customer Support & Services
16, Rue de Brévards
2002 Neuchatel 2
SWITZERLAND

Tel: +41-32-722-5555
Fax: +41-32-722-5578
e-mail: css@oscilloquartz.com

9.3.1.2 North America

Oscilloquartz USA
Customer Support & Services
14 Inverness Drive East, Suite F-240
Englewood, CO 80112-5640
USA

Tel: +1-303-790-0281
Fax: +1-303-790-9197
e-mail: osausa@oscilloquartz.com

9.3.2 Sales

For sales assistance, contact the following:

9.3.2.1 International

Oscilloquartz SA
Sales & Marketing
16, Rue de Brévards
2002 Neuchatel 2
SWITZERLAND

Tel: +41-32-722-5555
Fax: +41-32-722-5556
e-mail: osa@oscilloquartz.com

9.3.2.2 North America

Oscilloquartz USA
Sales & Marketing
14 Inverness Drive East, Suite F-240
Englewood, CO 80112-5640
USA

Tel: +1-303-790-0281
Fax: +1-303-790-9197
e-mail: osausa@oscilloquartz.com

This page has been intentionally left blank

Chapter

10 Diagrams & Drawings

Including :

- Introduction
- Block Diagram
- Front Panel
- Rear Panel

This page has been intentionally left blank

10.1 Introduction

The next few pages show the block diagram, the front panel and the back panel of the STS instrument. This information shows the names used throughout this document and facilitates the understanding of the function of the STS.

10.2 Block Diagram

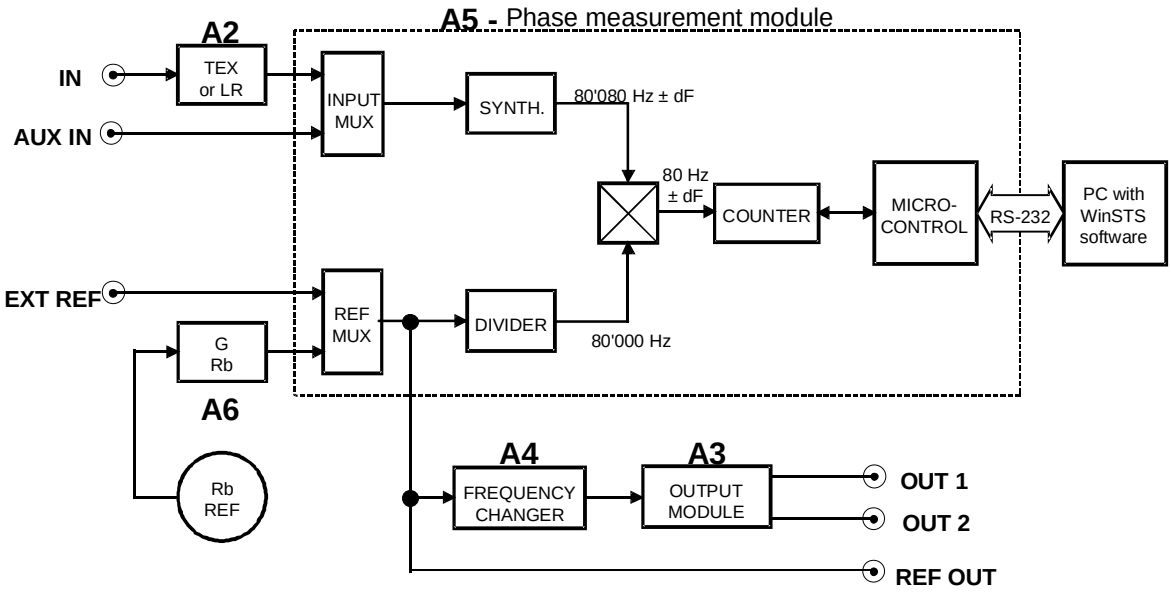


Figure 10-1 : STS 5565 Block Diagram

10.3 Front Panel

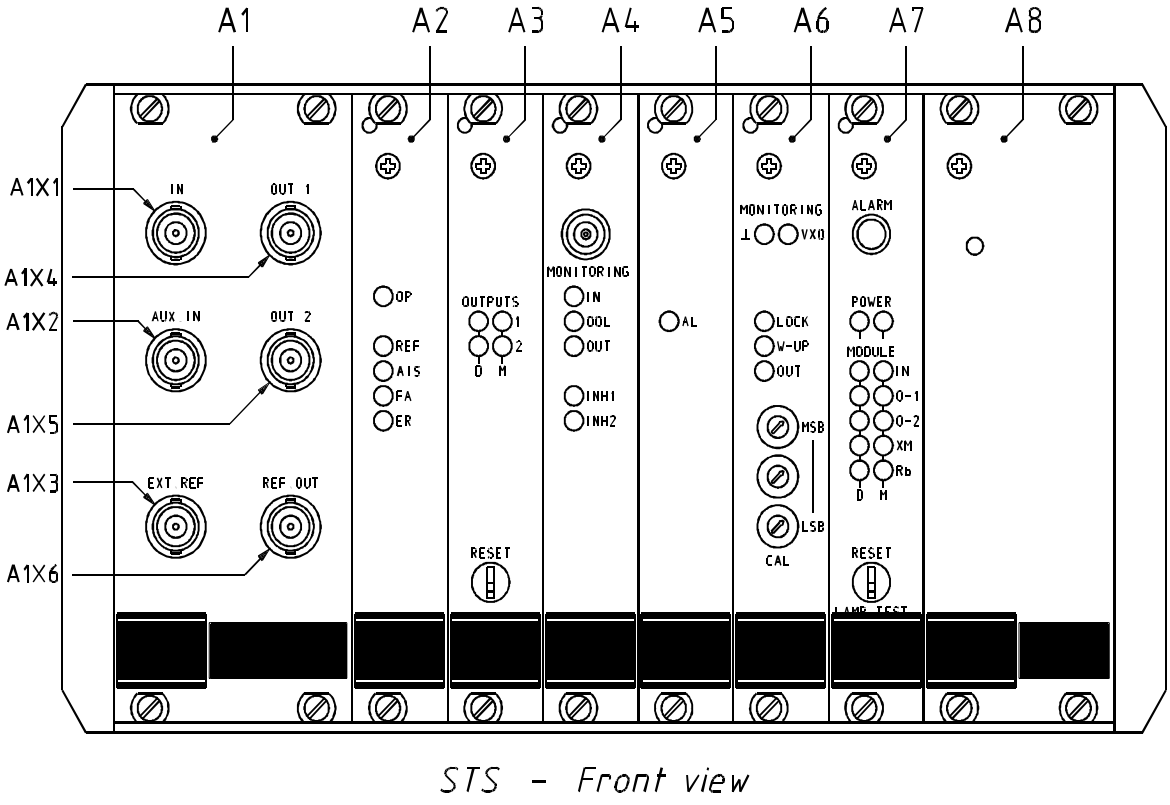


Figure 10-2 : STS 5565 Front Panel

10.4 Rear Panel

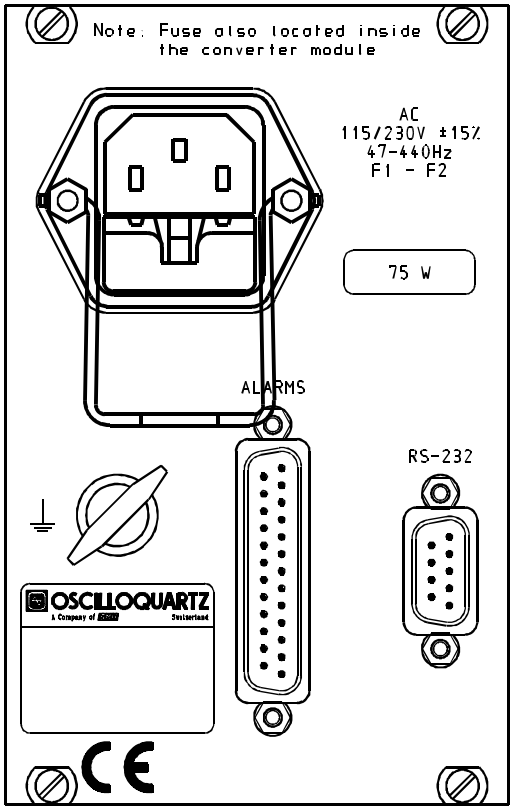


Figure 10-3 : STS 5565 Rear Panel

This page has been intentionally left blank

Chapter

11 Pre-defined Templates

Including :

- Introduction
- SSU Type Applications
- Standard Specifications per Equipment Type
- Network Limit for Wander at PRC Outputs
- Network Limit for Wander at SSU Outputs
- Network Limit for Wander at SEC Outputs
- Network Limit for Wander at PDH Distribution Outputs
- Wander Generation for PRC
- Wander Generation for SSU
- Noise Transfer for SSU
- Short-term Phase Transient Response for SSU
- Phase Discontinuity for SSU
- Wander Generation for SEC
- Noise Transfer for SEC
- Short-term Phase Transient Response for SEC
- Long-term Phase Transient Response (holdover) for SEC

This page has been intentionally left blank

11.1 Introduction

A set of predefined templates is attached to the WinSTS software. The Operating Manual of the OSA 5565 STS describes how these templates can be loaded and displayed on a screen, in order to compare them with measurement results. Annex A gives a description of each template and of its use.
The predefined templates for synchronisation equipment are derived from the latest ITU-T Recommendations:

- ITU-T Recommendation G.811 (05/96) for PRCs
- Draft ITU-T Recommendation G.812 (09/97) for SSUs
- ITU-T Recommendation G.813 (08/96) for SECs

Since ITU-T has not yet published recommendations on network limits for synchronisation networks, network limit templates are based on the European Telecommunication Standard ETS 300 462-3 (01/97).

11.2 SSU Type Applications

Draft ITU-T Recommendation G.812 (09/97) specifies six types of Synchronisation Supply Units (SSU). The primary applications of these SSU types are the following:

SSU Type	Primary Application	
	Which hierarchy?	Which cases?
Type I	2048 kbit/s	Synchronisation chains as long as the synchronisation reference chain specified in ITU-T Rec. G.803
Type II	1544[1] kbit/s	1) Distribution hubs[2] 2) In cases where only one single input reference is available
Type III	1544 kbit/s[3]	End offices[1]
Type IV	1544 kbit/s[3]	Existing[3] networks (comment: the bandwith of this clock is close to the bandwith of a SEC)
Type V	1544[3] & 2048 kbit/s	Existing[2] transit nodes; same as Transit Node Clock (TNC) in ITU-T Rec. G.812 - 1988
Type VI	2048 kbit/s	Existing[2] local nodes; same as Local Node Clock (LNC) in ITU-T Rec. G.812 - 1988

Table 11-1 SSU Type Applications

[1] See Bellcore terminology
[2] Prior to indroduction of SDH
[3] The 1544 kbit/s hierarchy includes the rates 1544 kbit/s, 6312 kbit/s and 44736 kbit/s.

***Note*:**

For secondary applications of these SSU types, refer to **section 2** of Draft ITU-T Recommendation G.812 (09/97).

11.3 Standard Specifications per Equipment Type

ITU-T Recommendation G.813 (08/96) specifies two types of SDH Equipment Slave Clocks called 'SEC Option 1' and 'SEC Option 2'. 'SEC Option 1' applies to SDH networks optimised for the 2048 kbit/s hierarchy. These networks allow synchronisation chains which are as long as the synchronisation reference chain specified in ITU-T Recommendation G.803. 'SEC Option 2' applies to SDH networks optimised for the particular 1544 kbit/s hierarchy, that includes the rates 1544 kbit/s, 6312 kbit/s and 44736 kbit/s. The synchronisation reference chain for these networks is still under study at ITU.

The specifications contained in ITU-T Recommendations G.811, Draft G.812 and G.813 are derived from other standards. The following table shows to which other standards they correspond:

ITU-T Rec.	Equipment Type	Other Standard	Equipment Type
G.811	PRC	ETS 300 462-6	Primary Reference Clock (PRC)
Draft G.812	SSU Type I	ETS 300 462-4	Synchronisation Supply Unit (SSU)
Draft G.812	SSU Type II	Draft ANSI T1.101	Stratum 2 Clock
Draft G.812	SSU Type III	Draft ANSI T1.101	Stratum 3E Clock
Draft G.812	SSU Type IV	Draft ANSI T1.101	Stratum 3 Clock
Draft G.812	SSU Type V	ITU-T G.812 - 1988	Transit Node Clock (TNC)
Draft G.812	SSU Type VI	ITU-T G.812 - 1988	Local Node Clock (LNC)
G.813	SEC Option 1	ETS 300 462-5	SDH Equipment Slave Clock (SEC)
G.813	SEC Option 2	Bellcore GR-253-CORE	SONET Minimum Clock (SMC)

Table 11-2 Standard Specifications per Equipment Type

11.4 Network Limit for Wander at PRC Outputs

11.4.1 Expressed as MTIE

Standard: ETS 300 462-3 (01/97)

File name: NETWORK LIMIT PRC ETS 300 462-3.mti

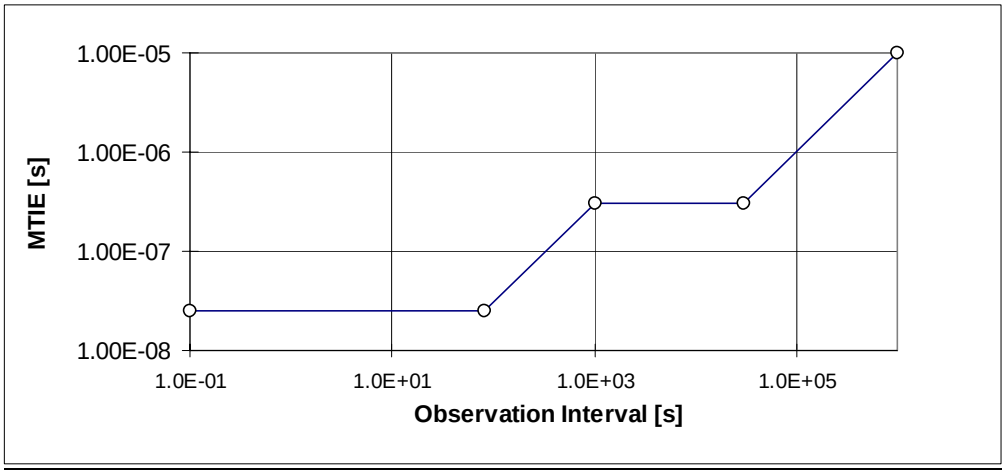
Object to which the specification applies: Synchronisation interface at a PRC output

Specified quantity and measurement conditions: In a synchronisation network, the wander at any interface of the type "synchronisation interface at a PRC output" must meet this mask.

Mathematical description (as specified in the standard):

MTIE [ns]	Observation Interval [s]
25	$0.1 < \tau \leq 83$
$0.3\ \tau$	$83 < \tau \leq 1000$
300	$1000 < \tau \leq 30\ 000$
$0.01\ \tau$	$\tau > 30\ 000$ s

Template (circles = points stored in the WinSTS template file):



Comments:

11.4.2 Expressed as TDEV

Standard: ETS 300 462-3 (01/97)

File name: NETWORK LIMIT PRC ETS 300 462-3.tdv

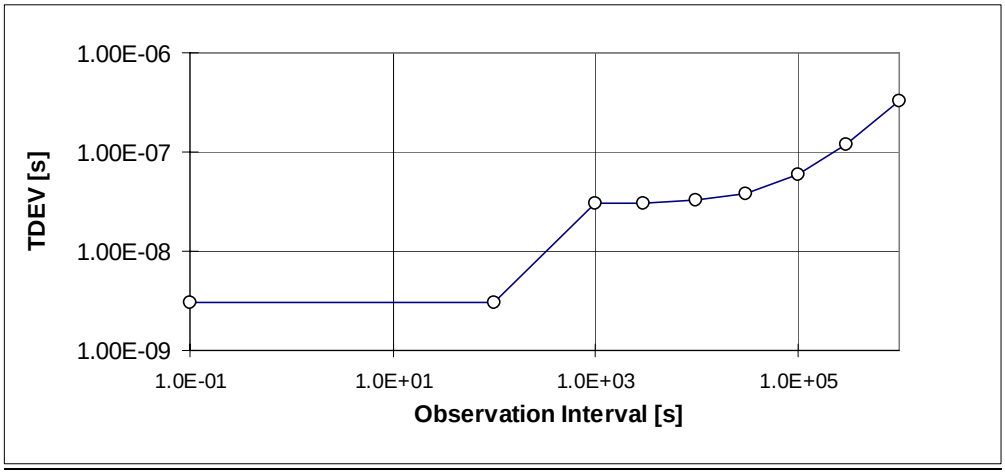
Object to which the specification applies: Synchronisation interface at a PRC output

Specified quantity and measurement conditions: In a synchronisation network, the wander at any interface of the type "synchronisation interface at a PRC output" must meet this mask.

Mathematical description (as specified in the standard):

TDEV [ns]	Observation Interval [s]
3	$0.1 < \tau \leq 100$
$0.03\ \tau$	$100 < \tau \leq 1000$
$29.7 + 0.0003\ \tau$	$1000 < \tau \leq 1\ 000\ 000$

Template (circles = points stored in the WinSTS template file):



Comments:

11.5 Network Limit for Wander at SSU Outputs

11.5.1 Expressed as MTIE

Standard: ETS 300 462-3 (01/97)

File name: NETWORK LIMIT SSU ETS 300 462-3.mti

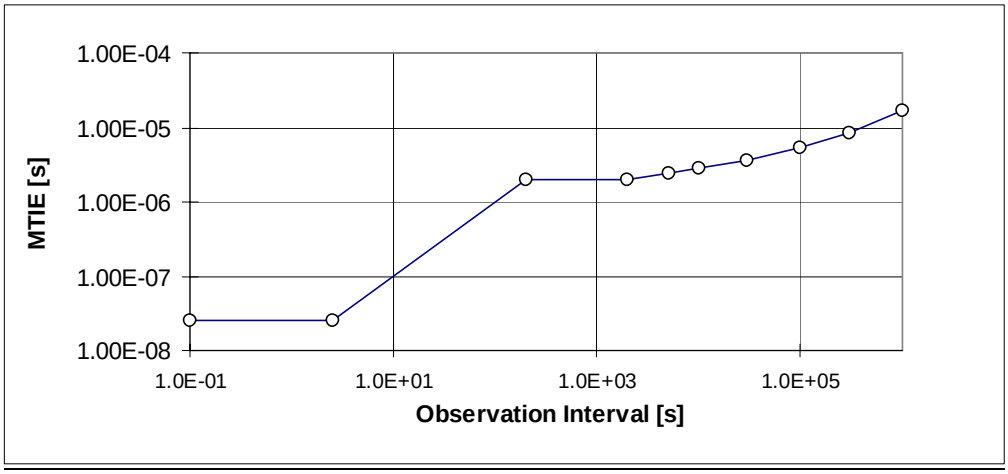
Object to which the specification applies: Synchronisation interface at an SSU output

Specified quantity and measurement conditions: In a synchronisation network, the wander at any interface of the type "synchronisation interface at an SSU output" must meet this mask.

Mathematical description (as specified in the standard):

MTIE [ns]	Observation Interval [s]
25	$0.1 < \tau \leq 2.5$
$10\ \tau$	$2.5 < \tau \leq 200$
2000	$200 < \tau \leq 2000$
$433\ \tau^{0.2} + 0.01\ \tau$	$\tau > 2000$

Template (circles = points stored in the WinSTS template file):



Comments:

11.5.2 Expressed as TDEV

Standard: ETS 300 462-3 (01/97)

File name: NETWORK LIMIT SSU ETS 300 462-3.tdv

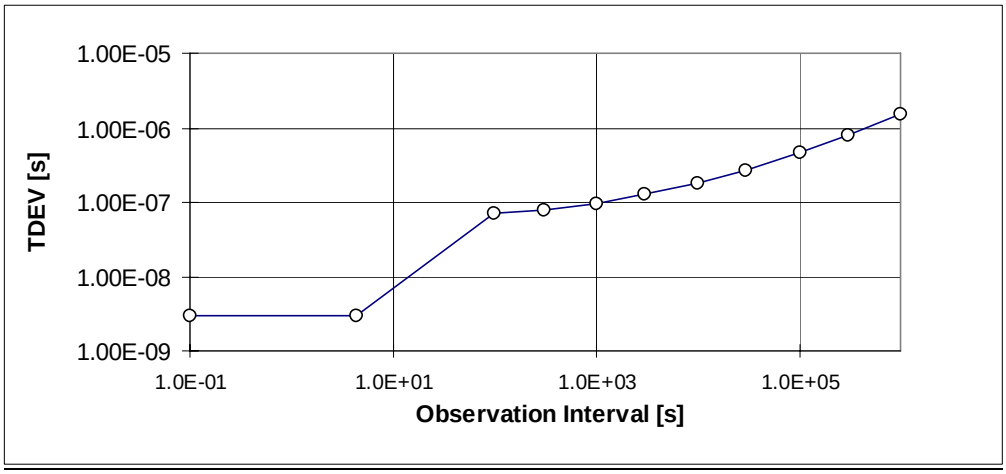
Object to which the specification applies: Synchronisation interface at an SSU output

Specified quantity and measurement conditions: In a synchronisation network, the wander at any interface of the type "synchronisation interface at an SSU output" must meet this mask.

Mathematical description (as specified in the standard):

TDEV [ns]	Observation Interval [s]
3	$0.1 < \tau \leq 4.3$
$0.7\ \tau$	$4.3 < \tau \leq 100$
$58 + 1.2\ \tau^{0.5} + 0.0003\ \tau$	$100 < \tau \leq 1\ 000\ 000$

Template (circles = points stored in the WinSTS template file):



Comments:

11.6 Network Limit for Wander at SEC Outputs

11.6.1 Expressed as MTIE

Standard: ETS 300 462-3 (01/97)

File name: NETWORK LIMIT SEC ETS 300 462-3.mti

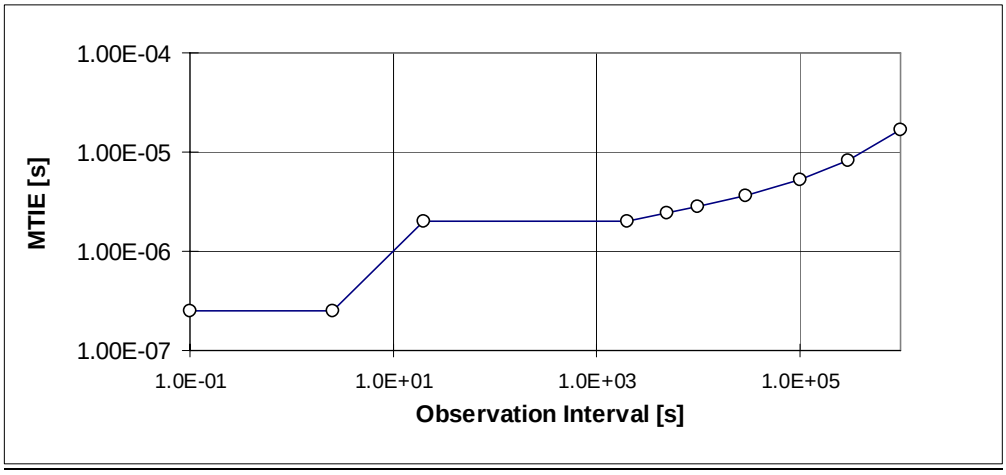
Object to which the specification applies: Synchronisation interface at a SEC output

Specified quantity and measurement conditions: In a synchronisation network, the wander at any interface of the type "synchronisation interface at a SEC output" must meet this mask.

Mathematical description (as specified in the standard):

MTIE [ns]	Observation Interval [s]
250	$0.1 < \tau \leq 2.5$
100 τ	$2.5 < \tau \leq 20$
2000	$20 < \tau \leq 2000$
433 $\tau^{0.2}$ + 0.01 τ	$\tau > 2000$

Template (circles = points stored in the WinSTS template file):



Comments:

11.6.2 Expressed as TDEV

Standard: ETS 300 462-3 (01/97)

File name: NETWORK LIMIT SEC ETS 300 462-3.tdv

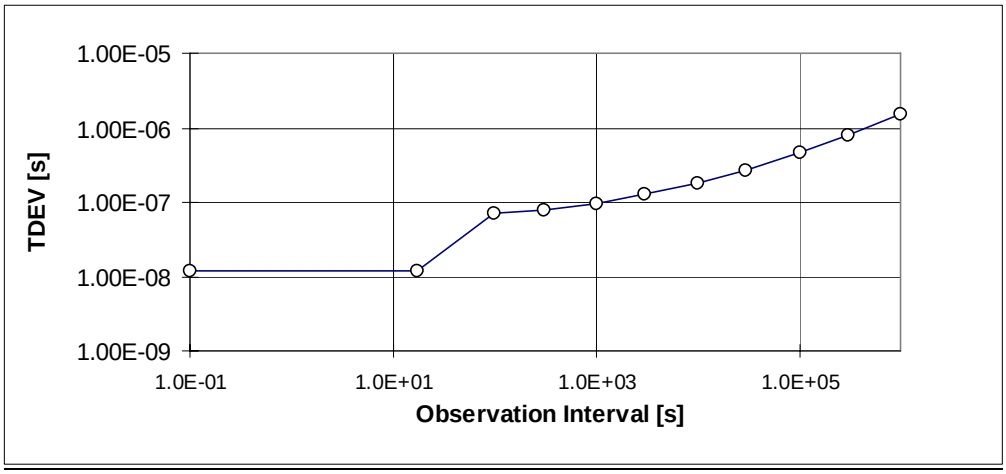
Object to which the specification applies: Synchronisation interface at a SEC output

Specified quantity and measurement conditions: In a synchronisation network, the wander at any interface of the type "synchronisation interface at a SEC output" must meet this mask.

Mathematical description (as specified in the standard):

TDEV [ns]	Observation Interval [s]
12	$0.1 < \tau \leq 17.14$
$0.7\ \tau$	$17.14 < \tau \leq 100$
$58 + 1.2\ \tau^{0.5} + 0.0003$	$100 < \tau \leq 1\ 000\ 000$

Template (circles = points stored in the WinSTS template file):



Comments:

11.7 Network Limit for Wander at PDH Distribution Outputs

11.7.1 Expressed as MTIE

Standard: ETS 300 462-3 (01/97)

File name: NETWORK LIMIT PDH ETS 300 462-3.mti

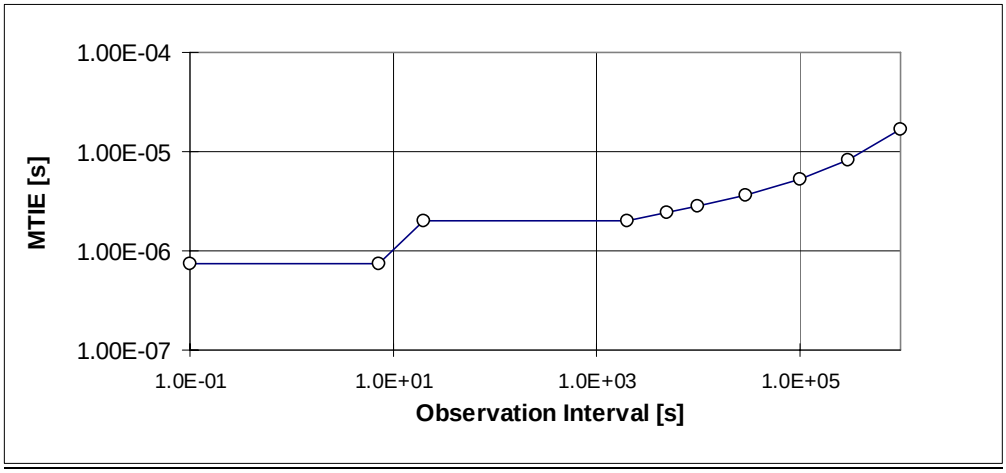
Object to which the specification applies: Synchronisation interface at a PDH distribution output

Specified quantity and measurement conditions: In a synchronisation network, the wander at any interface of the type "synchronisation interface at a PDH distribution output" must meet this mask.

Mathematical description (as specified in the standard):

MTIE [ns]	Observation Interval [s]
732	$0.1 < \tau \leq 7.3$
100 τ	$7.3 < \tau \leq 20$
2000	$20 < \tau \leq 2000$
433 $\tau^{0.2}$ + 0.01 τ	$\tau > 2000$

Template (circles = points stored in the WinSTS template file):



Comments:

11.7.2 Expressed as TDEV

Standard: ETS 300 462-3 (01/97)

File name: NETWORK LIMIT PDH ETS 300 462-3.tdv

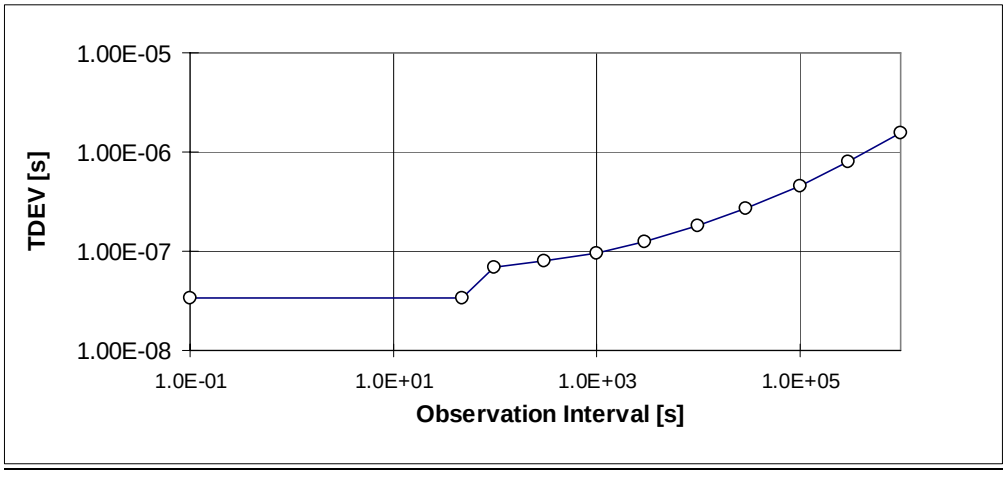
Object to which the specification applies: Synchronisation interface at a PDH distribution output

Specified quantity and measurement conditions: In a synchronisation network, the wander at any interface of the type "synchronisation interface at a PDH distribution output" must meet this mask.

Mathematical description (as specified in the standard):

TDEV [ns]	Observation Interval [s]
34	$0.1 < \tau \leq 48$
$0.7\ \tau$	$48 < \tau \leq 100$
$58 + 1.2\ \tau^{0.5} + 0.0003\ \tau$ ns	$100 < \tau \leq 1\ 000\ 000$

Template (circles = points stored in the WinSTS template file):



Comments:

11.8 Wander Generation for PRC

11.8.1 Expressed as MTIE

Standard: ITU-T Recommendation G.811 (05/96)

File name: WANDER GENERATION PRC G811.mti

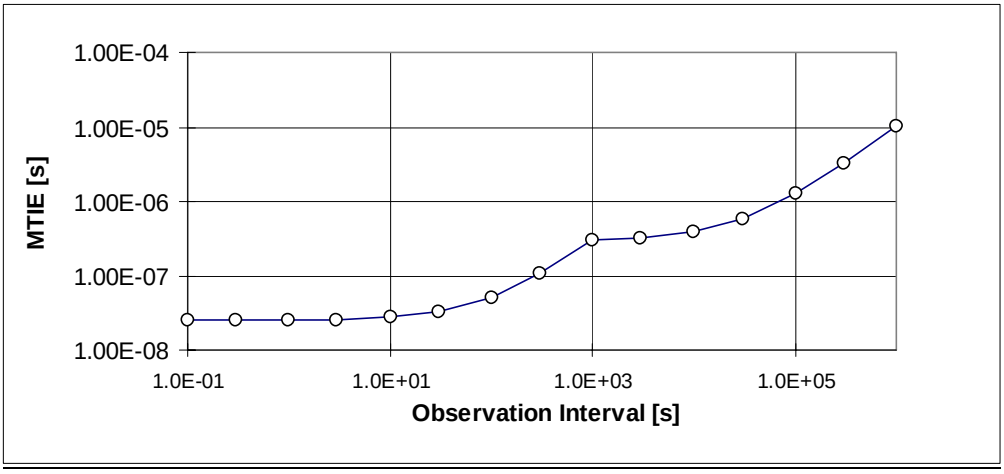
Object to which the specification applies: Primary Reference Clock (PRC)

Specified quantity and measurement conditions: The wander at the output of a Primary Reference Clock must meet this mask.

Mathematical description (as specified in the standard):

MTIE [µs]	Observation Interval [s]
0.275E-3 τ + 0.025	0.1 < $\tau \leq$ 1000
1E-5 τ + 0.29	τ > 1000

Template (circles = points stored in the WinSTS template file):



Comments:

11.8.2 Expressed as TDEV

Standard: ITU-T Recommendation G.811 (05/96)

File name: WANDER GENERATION PRC G811.tdv

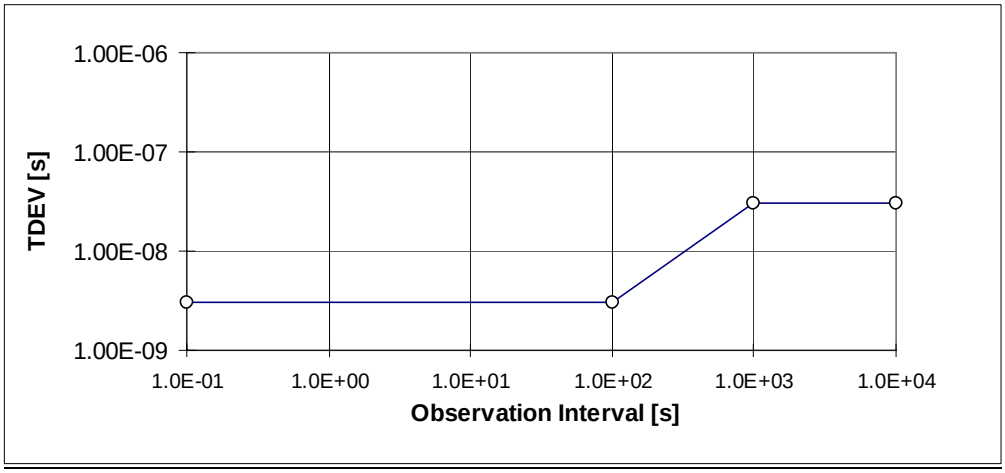
Object to which the specification applies: Primary Reference Clock (PRC)

Specified quantity and measurement conditions: The wander at the output of a Primary Reference Clock must meet this mask.

Mathematical description (as specified in the standard):

TDEV [ns]	Observation Interval [s]
3	$0.1 < \tau \leq 100$
$0.03\ \tau$	$100 < \tau \leq 1000$
30	$1000 < \tau \leq 10\ 000$

Template (circles = points stored in the WinSTS template file):



Comments:

11.9 Wander Generation for SSU

11.9.1 SSU Type I

11.9.1.1 At Constant Temperature Expressed as MTIE

Standard: Draft ITU-T Recommendation G.812 (09/97)

File name: WANDER GENERATION SSU I G812.mti

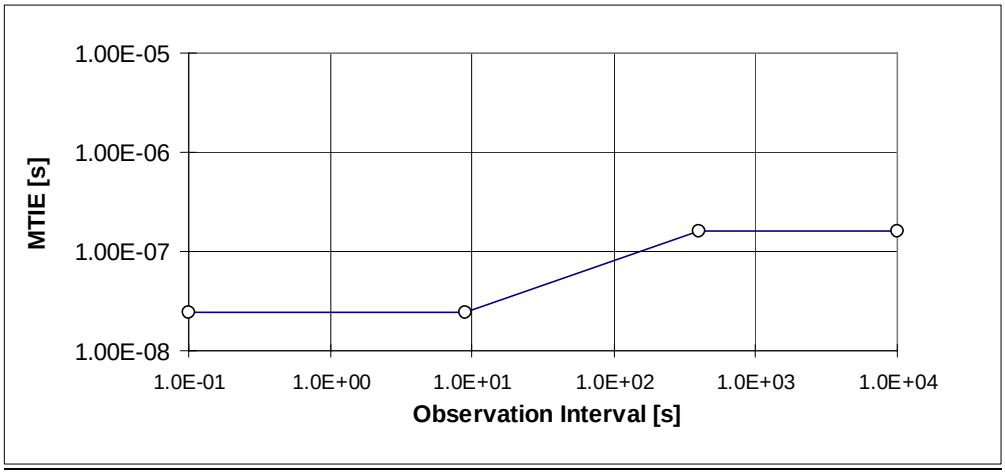
Object to which the specification applies: Synchronisation Supply Unit (SSU) Type I

Specified quantity and measurement conditions: The wander at the output of a Synchronisation Supply Unit of Type I must meet this mask when the input is connected to an ideal reference signal and when the ambient temperature is constant (± 1 K).

Mathematical description (as specified in the standard):

MTIE [ns]	Observation Interval [s]
24	$0.1 < \tau \leq 9$
$8\ \tau^{0.5}$	$9 < \tau \leq 400$
160	$400 < \tau \leq 10\ 000$

Template (circles = points stored in the WinSTS template file):



Comments: For testing, the reference signal applied to the input of the clock must have a stability level that is at least 10 times better than the above output requirement.

11.9.1.2 At Variable Temperature Expressed as MTIE

Standard: Draft ITU-T Recommendation G.812 (09/97)

File name: WANDER GEN VAR TEMP SSU I G812.mti

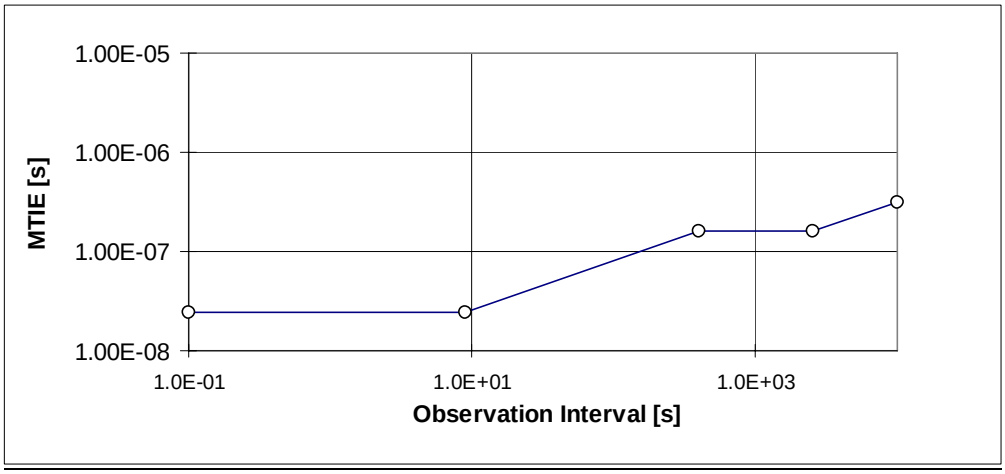
Object to which the specification applies: Synchronisation Supply Unit (SSU) Type I

Specified quantity and measurement conditions: The wander at the output of a Synchronisation Supply Unit of Type I must meet this mask when the input is connected to an ideal reference signal and when the ambient temperature is variable (range and rate of change to be defined).

Mathematical description (as specified in the standard):

MTIE [ns]	Observation Interval [s]
24	$0.1 < \tau \leq 9$
$8\ \tau^{0.5}$	$9 < \tau \leq 400$
160	$400 < \tau \leq 2500$
$3.2\ \tau^{0.5}$	$2500 < \tau \leq 10\ 000$

Template (circles = points stored in the WinSTS template file):



Comments: For testing, the reference signal applied to the input of the clock must have a stability level that is at least 10 times better than the above output requirement.

11.9.1.3 At Constant Temperature Expressed as TDEV

Standard: Draft ITU-T Recommendation G.812 (09/97)

File name: WANDER GENERATION SSU I G812.tdv

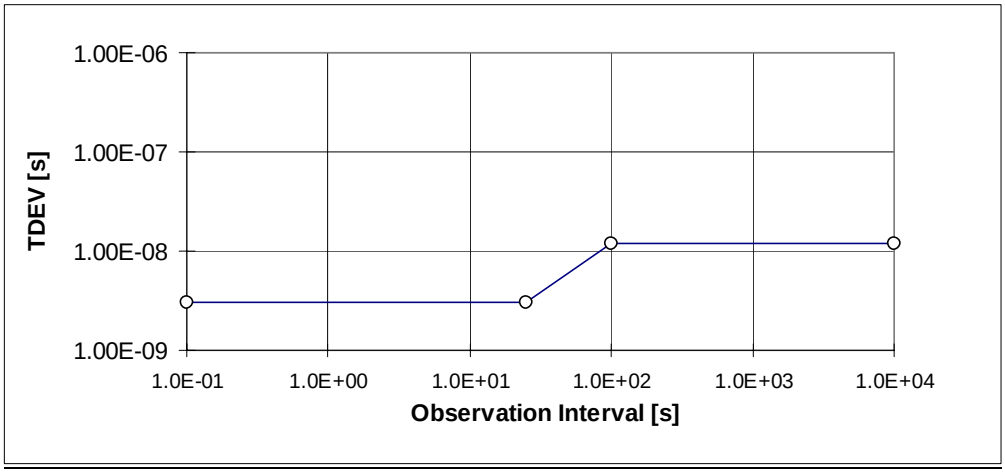
Object to which the specification applies: Synchronisation Supply Unit (SSU) Type I

Specified quantity and measurement conditions: The wander at the output of a Synchronisation Supply Unit of Type I must meet this mask when the input is connected to an ideal reference signal and when the ambient temperature is constant (+ 1 K).

Mathematical description (as specified in the standard):

TDEV [ns]	Observation Interval [s]
3	$0.1 < \tau \leq 25$
$0.12\ \tau$	$25 < \tau \leq 100$
12	$100 < \tau \leq 10\ 000$

Template (circles = points stored in the WinSTS template file):



Comments: For testing, the reference signal applied to the input of the clock must have a stability level that is at least 10 times better than the above output requirement.

11.9.2 SSU Types II & III

11.9.2.1 At Constant Temperature Expressed as MTIE

Standard: Draft ITU-T Recommendation G.812 (09/97)

File name: WANDER GENERATION SSU II&III G812.mti

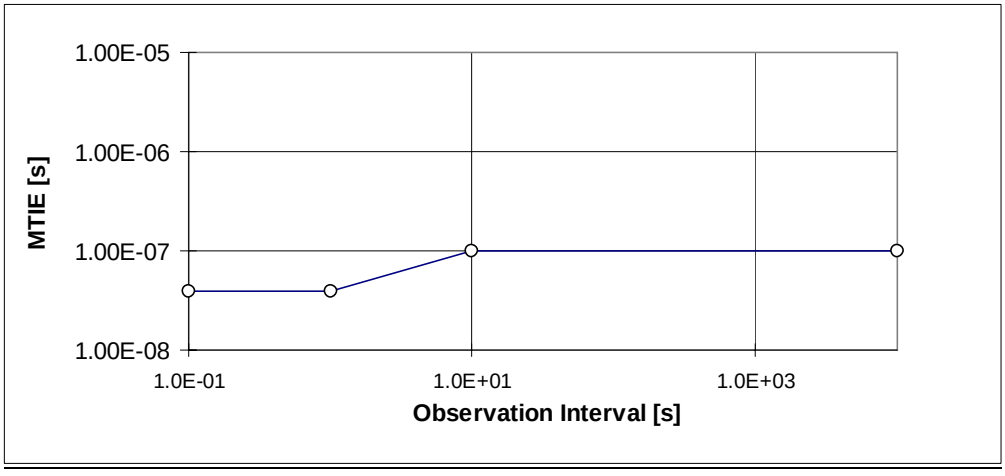
Object to which the specification applies: Synchronisation Supply Unit (SSU) Types II & III

Specified quantity and measurement conditions: The wander at the output of a Synchronisation Supply Unit of Type II or III must meet this mask when the input is connected to an ideal reference signal and when the ambient temperature is constant (+ 1 K).

Mathematical description (as specified in the standard):

MTIE [ns]	Observation Interval [s]
40	$0.1 < \tau \leq 1$
$40\ \tau^{0.4}$	$1 < \tau \leq 10$
100	$\tau > 10$

Template (circles = points stored in the WinSTS template file):



Comments: For testing, the reference signal applied to the input of the clock must have a stability level that is at least 10 times better than the above output requirement.

11.9.2.2 At Constant Temperature Expressed as TDEV

Standard: Draft ITU-T Recommendation G.812 (09/97)

File name: WANDER GENERATION SSU II&III G812.tdv

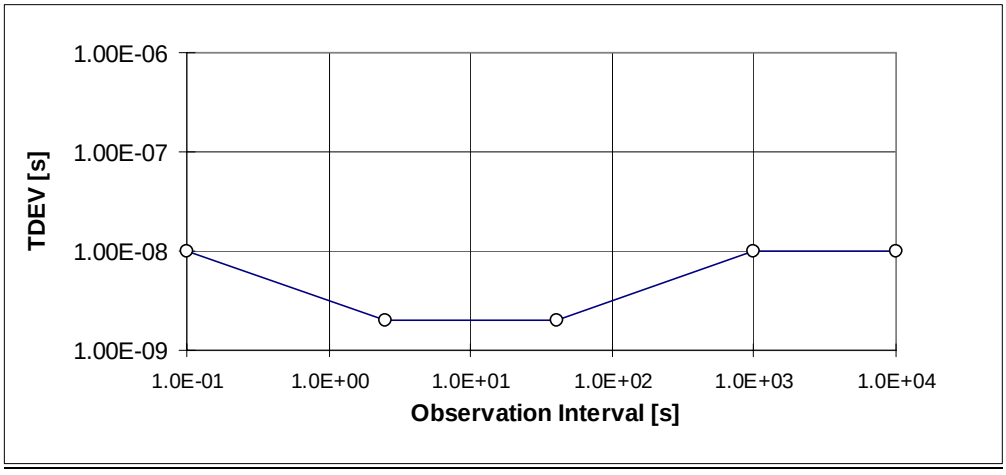
Object to which the specification applies: Synchronisation Supply Unit (SSU) Types II & III

Specified quantity and measurement conditions: The wander at the output of a Synchronisation Supply Unit of Type II or III must meet this mask when the input is connected to an ideal reference signal and when the ambient temperature is constant (± 1 K).

Mathematical description (as specified in the standard):

TDEV [ns]	Observation Interval [s]
$3.2\ \tau^{-0.5}$	$0.1 < \tau \leq 2.5$
2	$2.5 < \tau \leq 40$
$0.32\ \tau^{0.5}$	$40 < \tau \leq 1000$
10	$\tau > 1000$

Template (circles = points stored in the WinSTS template file):



Comments: For testing, the reference signal applied to the input of the clock must have a stability level that is at least 10 times better than the above output requirement.

11.9.3 SSU Type IV

11.9.3.1 At Constant Temperature Expressed as MTIE

Standard: Draft ITU-T Recommendation G.812 (09/97)

File name: WANDER GENERATION SSU IV G812.mti

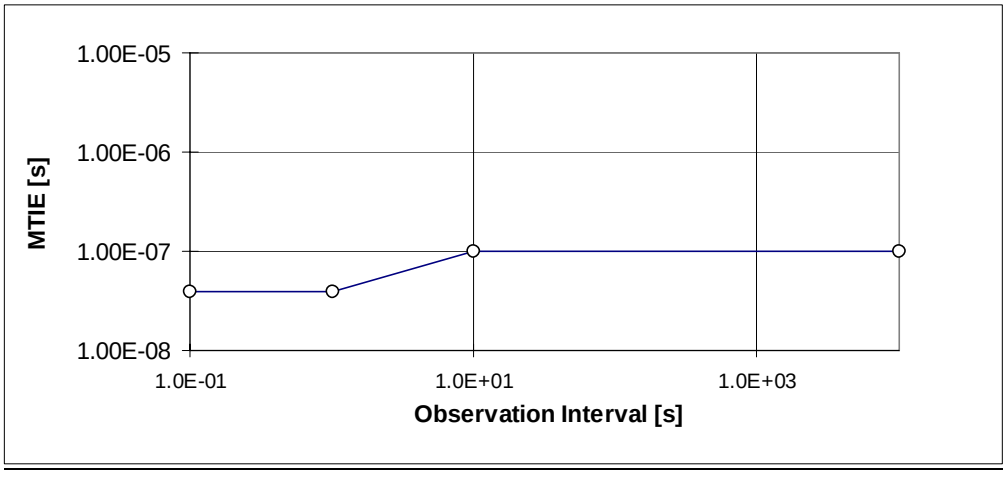
Object to which the specification applies: Synchronisation Supply Unit (SSU) Type IV

Specified quantity and measurement conditions: The wander at the output of a Synchronisation Supply Unit of Type IV, must meet this mask when the input is connected to an ideal reference signal and when the ambient temperature is constant (± 1 K).

Mathematical description (as specified in the standard):

MTIE [ns]	Observation Interval [s]
40	$0.1 < \tau \leq 1$
$40\ \tau^{0.4}$	$1 < \tau \leq 10$
100	$\tau > 10$

Template (circles = points stored in the WinSTS template file):



Comments: For testing, the reference signal applied to the input of the clock must have a stability level that is at least 10 times better than the above output requirement.

11.9.3.2 At Constant Temperature Expressed as TDEV

Standard: Draft ITU-T Recommendation G.812 (09/97)

File name: WANDER GENERATION SSU IV G812.tdv

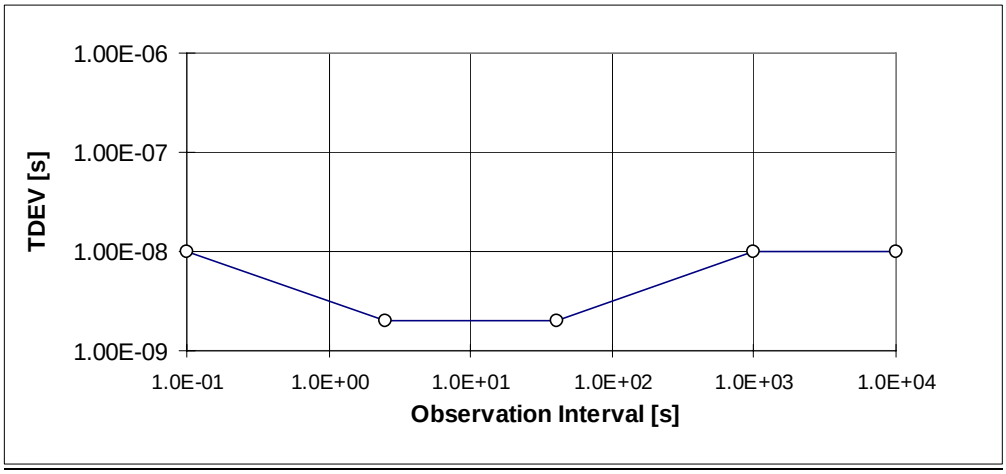
Object to which the specification applies: Synchronisation Supply Unit (SSU) Type IV

Specified quantity and measurement conditions: The wander at the output of a Synchronisation Supply Unit of Type IV must meet this mask when the input is connected to an ideal reference signal and when the ambient temperature is constant (+ 1 K).

Mathematical Description (as specified in the standard):

TDEV [ns]	Observation Interval [s]
$3.2\ \tau^{-0.5}$	$0.1 < \tau \leq 2.5$
2	$2.5 < \tau \leq 40$
$0.32\ \tau^{0.5}$	$40 < \tau \leq 1000$
10	$\tau > 1000$

Template (circles = points stored in the WinSTS template file):



Comments: For testing, the reference signal applied to the input of the clock must have a stability level that is at least 10 times better than the above output requirement.

11.9.4 SSU Types V & VI

11.9.4.1 At Constant Temperature Expressed as MTIE

Standard: Draft ITU-T Recommendation G.812 (09/97)

File name: WANDER GENERATION SSU V&VI G812.mti

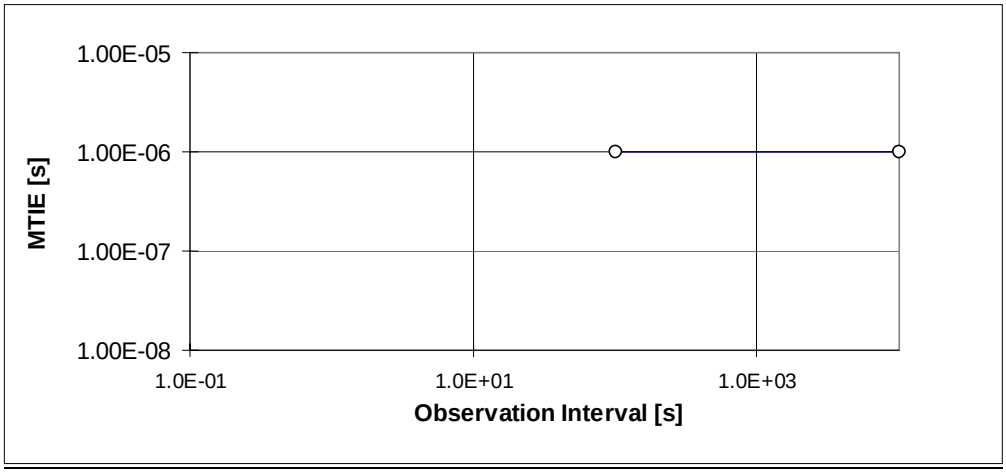
Object to which the specification applies: Synchronisation Supply Unit (SSU) Types V & VI

Specified quantity and measurement conditions: The wander at the output of a Synchronisation Supply Unit of Type V or VI must meet this mask when the input is connected to an ideal reference signal and when the ambient temperature is constant (+ 1 K).

Mathematical description (as specified in the standard):

MTIE [ns]	Observation Interval [s]
1000	$\tau > 100$

Template (circles = points stored in the WinSTS template file):



Comments: For testing, the reference signal applied to the input of the clock must have a stability level that is at least 10 times better than the above output requirement.

11.10 Noise Transfer for SSU

11.10.1 SSU Type I Expressed as TDEV

Standard: Draft ITU-T Recommendation G.812 (09/97)

File name: NOISE TRANSFER SSU I G812.tdv

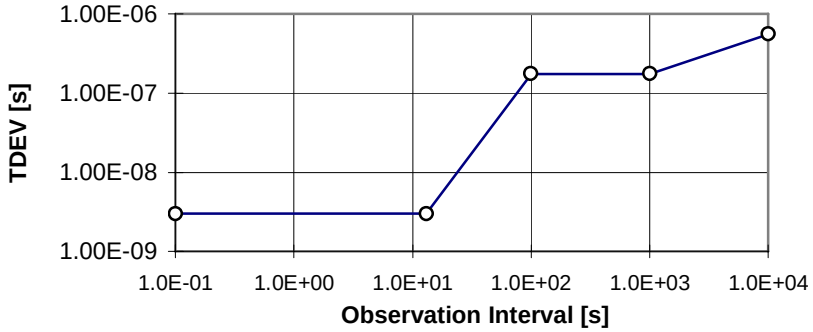
Object to which the specification applies: Synchronisation Supply Unit (SSU) Type I

Specified quantity and measurement conditions: The wander at the output of a Synchronisation Supply Unit of Type I must meet this mask when the input reference has a TDEV that is equal to the Wander Tolerance specification.

Mathematical description (as specified in the standard):

TDEV [ns]	Observation Interval [s]
3	$0.1 < \tau \leq 13.1$
$0.0176\ \tau^2$	$13.1 < \tau \leq 100$
176	$100 < \tau \leq 1000$
$5.58\ \tau^{0.5}$	$1000 < \tau \leq 10\ 000$

Template (circles = points stored in the WinSTS template file):



Comments: Wander Tolerance (TDEV) for SSU Type I in Draft ITU-T Rec. G.812 (09/97):

TDEV [ns]	Observation Interval [s]
34	$0.1 < \tau \leq 20$
$1.7\ \tau$	$20 < \tau \leq 100$
170	$100 < \tau \leq 1000$
$5.4\ \tau^{0.5}$	$1000 < \tau \leq 10\ 000$

11.10.2 SSU Types II & III Expressed as TDEV

Standard: Draft ITU-T Recommendation G.812 (09/97)

File name: NOISE TRANSFER SSU II&III G812.tdv

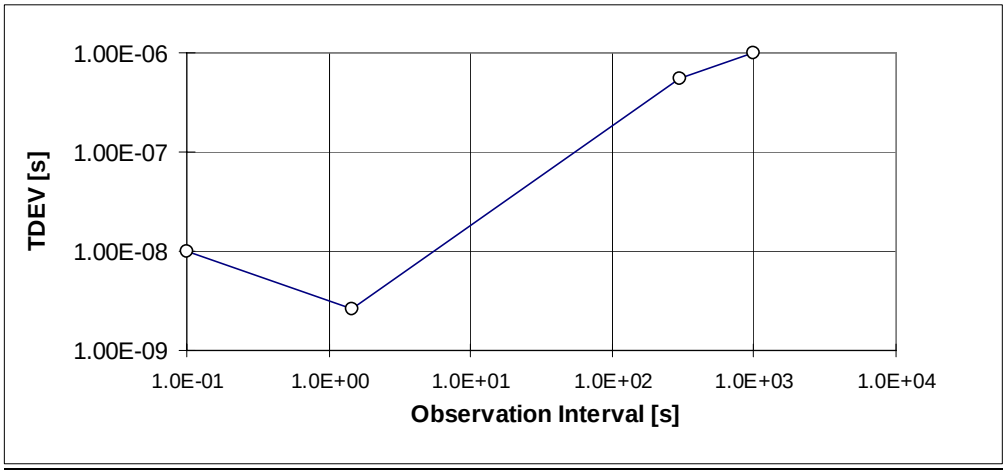
Object to which the specification applies: Synchronisation Supply Unit (SSU) Type I

Specified quantity and measurement conditions: The wander at the output of a Synchronisation Supply Unit of Type II or III must meet this mask when the input reference has a TDEV that is equal to the Wander Tolerance specification.

Mathematical description (as specified in the standard):

TDEV [ns]	Observation Interval [s]
$3.2\ \tau^{-0.5}$	$0.1 < \tau \leq 1.44$
$1.86\ \tau$	$1.44 < \tau \leq 300$
$32.2\ \tau^{0.5}$	$300 < \tau \leq 1000$

Template (circles = points stored in the WinSTS template file):



Comments: Wander Tolerance (TDEV) for SSU Type II & III in Draft ITU-T Rec. G.812 (09/97):

TDEV [ns]	Observation Interval [s]
100	$0.05 < \tau \leq 10$
$31.6\ \tau^{0.5}$	$10 < \tau \leq 1000$
for further study	$\tau > 1000$

11.10.3 SSU Type IV Expressed as TDEV

Standard: Draft ITU-T Recommendation G.812 (09/97)

File name: NOISE TRANSFER SSU IV G812.tdv

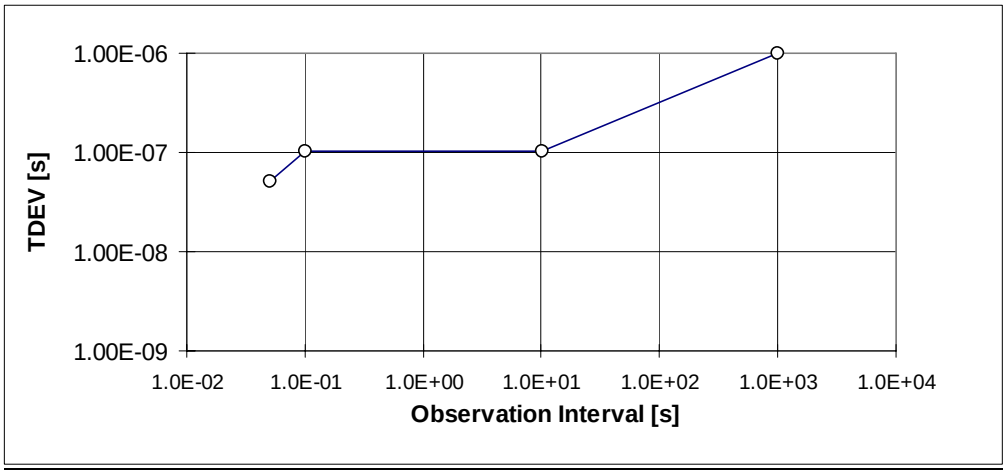
Object to which the specification applies: Synchronisation Supply Unit (SSU) Type IV

Specified quantity and measurement conditions: The wander at the output of a Synchronisation Supply Unit of Type IV must meet this mask when the input reference has a TDEV that is equal to the Wander Tolerance specification.

Mathematical Description (as specified in the standard):

TDEV [ns]	Observation Interval [s]
1020 τ	$0.05 < \tau \leq 0.1$
102	$0.1 < \tau \leq 10$
32.2 $\tau^{0.5}$	$10 < \tau \leq 1000$

Template (circles = points stored in the WinSTS template file):



Comments: Wander Tolerance (TDEV) for SSU Type IV in Draft ITU-T Rec. G.812 (09/97):

TDEV [ns]	Observation Interval [s]
100	$0.05 < \tau \leq 10$
31.6 $\tau^{0.5}$	$10 < \tau \leq 1000$
for further study	$\tau > 1000$

11.11 Short-term Phase Transient Response for SSU

11.11.1 SSU Type I Expressed as MTIE

Standard: Draft ITU-T Recommendation G.812 (09/97)

File name: SHORT TRANSIENT SSU I G812.mti

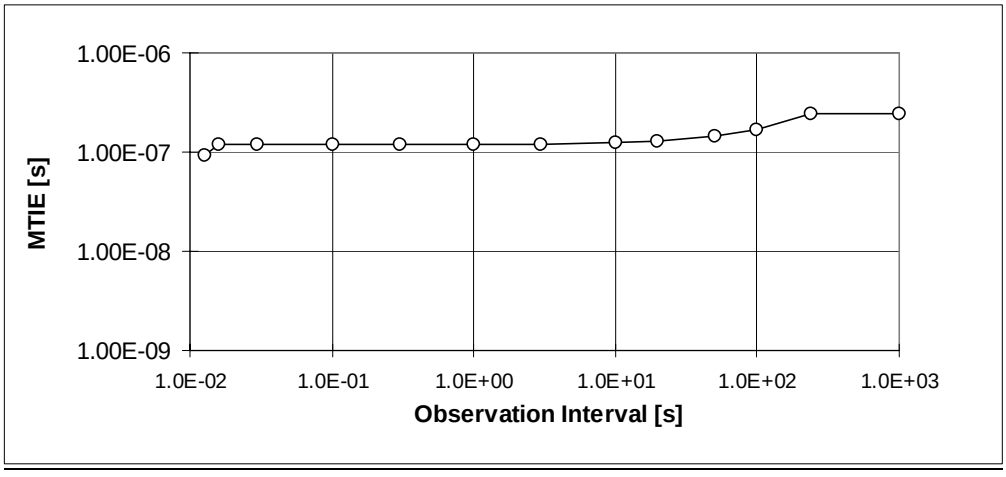
Object to which the specification applies: Synchronisation Supply Unit (SSU) Type I

Specified quantity and measurement conditions: The phase transient response at the output of a Synchronisation Supply Unit of Type I must meet this mask, when the currently selected input reference is lost and a second reference, traceable to the same reference clock, is selected instead.

Mathematical description (as specified in the standard):

MTIE	Observation Interval
25	$0.001 < \tau \leq 0.0033$
$7500\ \tau$	$0.0033 < \tau \leq 0.016$
$120 + 0.5\ \tau$	$0.016 < \tau \leq 240$
240	$240 < \tau \leq 1000$

Template (circles = points stored in the WinSTS template file):



Comments: This mask is applicable to 2048 kHz and 2048 kbit/s interfaces. A different mask applies to STM-N interfaces - see Draft ITU-T Rec. G.812 (09/97).

11.11.2 SSU Types II & III Expressed as MTIE

Standard: Draft ITU-T Recommendation G.812 (09/97)

File name: SHORT TRANSIENT SSU II&III G812.mti

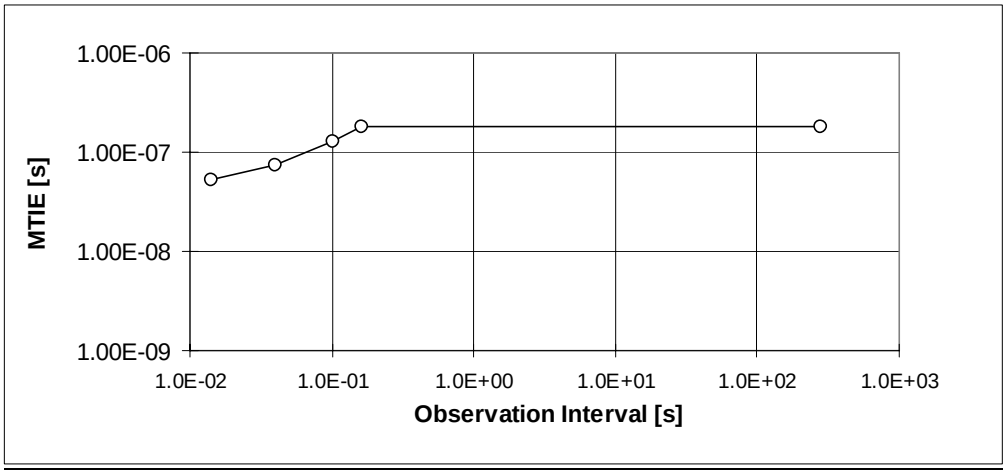
Object to which the specification applies: Synchronisation Supply Unit (SSU) Types II & III

Specified quantity and measurement conditions: The phase transient response at the output of a Synchronisation Supply Unit of Type II or III must meet this mask when the currently selected input reference is lost and a second reference, traceable to the same reference clock, is selected instead.

Mathematical description (as specified in the standard):

MTIE	Observation Interval
40 + 885 τ	$0.014 < \tau \leq 0.16$
182	$0.16 < \tau \leq 280$

Template (circles = points stored in the WinSTS template file):



Comments: This mask is applicable 1544 kbit/s interfaces. A different mask applies to STM-N interfaces - see Draft ITU-T Rec. G.812 (09/97).

11.11.3 SSU Type IV Expressed as MTIE

Standard: Draft ITU-T Recommendation G.812 (09/97)

File name: SHORT TRANSIENT SSU IV G812.mti

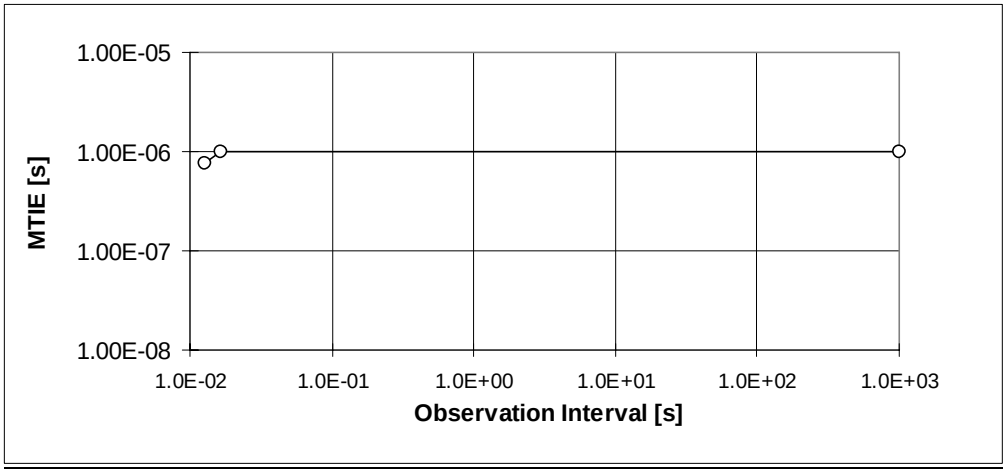
Object to which the specification applies: Synchronisation Supply Unit (SSU) Type IV

Specified quantity and measurement conditions: The phase transient response at the output of a Synchronisation Supply Unit Type IV must meet this mask when the currently selected input reference is lost and a second reference, traceable to the same reference clock, is selected instead.

Mathematical description (as specified in the standard):

MTIE	Observation Interval
61 000 τ	$0.00133 < \tau \leq 0.0164$
1000	$\tau > 0.0164$

Template (circles = points stored in the WinSTS template file):



Comments: This mask is applicable to 1544 kbit/s interfaces. A different mask applies to STM-N interfaces - see Draft ITU-T Rec. G.812 (09/97).

11.11.4 SSU Types V & VI Expressed as MTIE

Standard: Draft ITU-T Recommendation G.812 (09/97)

File name: SHORT TRANSIENT SSU V&VI G812.mti

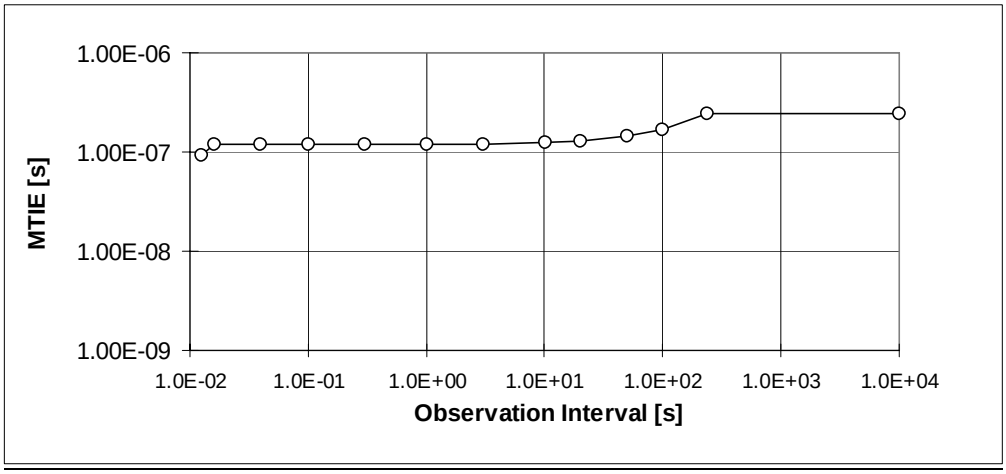
Object to which the specification applies: Synchronisation Supply Unit (SSU) Type V & VI

Specified quantity and measurement conditions: The phase transient response at the output of a Synchronisation Supply Unit of Type V or VI must meet this mask when the currently selected input reference is lost and a second reference, traceable to the same reference clock, is selected instead.

Mathematical description (as specified in the standard):

MTIE	Observation Interval
25	$0.001 < \tau \leq 0.0033$
$7500\ \tau$	$0.0033 < \tau \leq 0.016$
$120 + 0.5\ \tau$	$0.016 < \tau \leq 240$
240	$240 < \tau \leq 10\ 000$

Template (circles = points stored in the WinSTS template file):



Comments: This mask is applicable to 2048 kHz and 2048 kbit/s interfaces. A different mask applies to STM-N interfaces - see Draft ITU-T Rec. G.812 (09/97).

11.12 Phase Discontinuity for SSU

11.12.1 SSU Type I Expressed as MTIE

Standard: Draft ITU-T Recommendation G.812 (09/97)

File name: PHASE DISCONTINUITY SSU I G812.mti

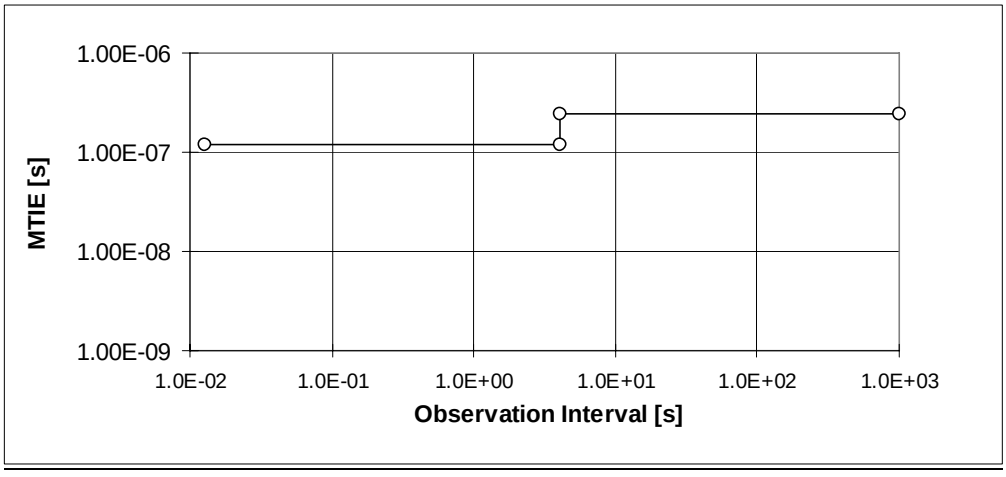
Object to which the specification applies: Synchronisation Supply Unit (SSU) Type I

Specified quantity and measurement conditions: The phase transient response at the output of a Synchronisation Supply Unit of Type I must meet this mask in cases of infrequent internal testing or rearrangement operations within the Synchronisation Supply Unit.

Mathematical description (as specified in the standard):

MTIE [ns]	Observation Interval [s]
60	$\tau \leq 0.001$
120	$0.001 < \tau \leq 4$
240	$\tau > 4$

Template (circles = points stored in the WinSTS template file):



Comments:

11.12.2 SSU Types II & III Expressed as MTIE

Standard: Draft ITU-T Recommendation G.812 (09/97)

File name: PHASE DISCONTINUITY SSU II&III G812.mti

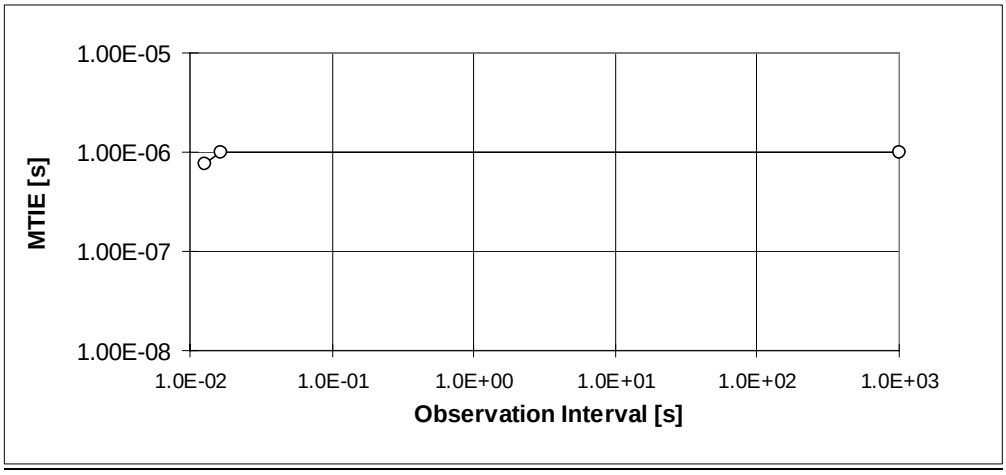
Object to which the specification applies: Synchronisation Supply Unit (SSU) Types II & III

Specified quantity and measurement conditions: The phase transient response at the output of a Synchronisation Supply Unit of Type II or III must meet this mask in cases of infrequent internal testing or rearrangement operations within the Synchronisation Supply Unit.

Mathematical description (as specified in the standard):

MTIE [ns]	Observation Interval [s]
61 000 τ	$0.00133 < \tau \leq 0.0164$
1000	$\tau > 0.0164$

Template (circles = points stored in the WinSTS template file):



Comments:

11.12.3 SSU Type IV Expressed as MTIE

Standard: Draft ITU-T Recommendation G.812 (09/97)

File name: PHASE DISCONTINUITY SSU IV G812.mti

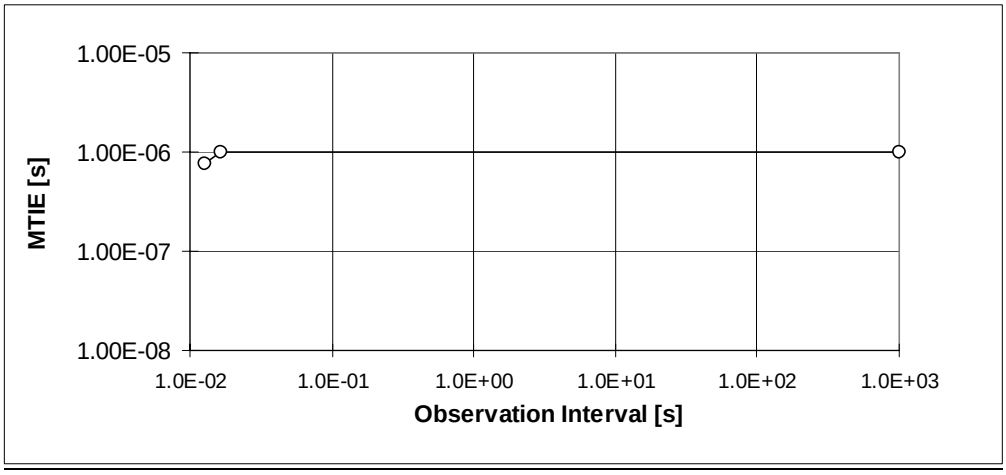
Object to which the specification applies: Synchronisation Supply Unit (SSU) Type IV

Specified quantity and measurement conditions: The phase transient response at the output of a Synchronisation Supply Unit of Type IV must meet this mask in cases of infrequent internal testing or rearrangement operations within the Synchronisation Supply Unit.

Mathematical description (as specified in the standard):

MTIE [ns]	Observation Interval [s]
Not Applicable	$\tau \leq 0.00133$
61 000 τ	$0.00133 < \tau \leq 0.0164$
1000	$\tau > 0.0164$

Template (circles = points stored in the WinSTS template file):



Comments:

11.12.4 SSU Types V & VI Expressed as MTIE

Standard: Draft ITU-T Recommendation G.812 (09/97)

File name: PHASE DISCONTINUITY SSU V&VI G812.mti

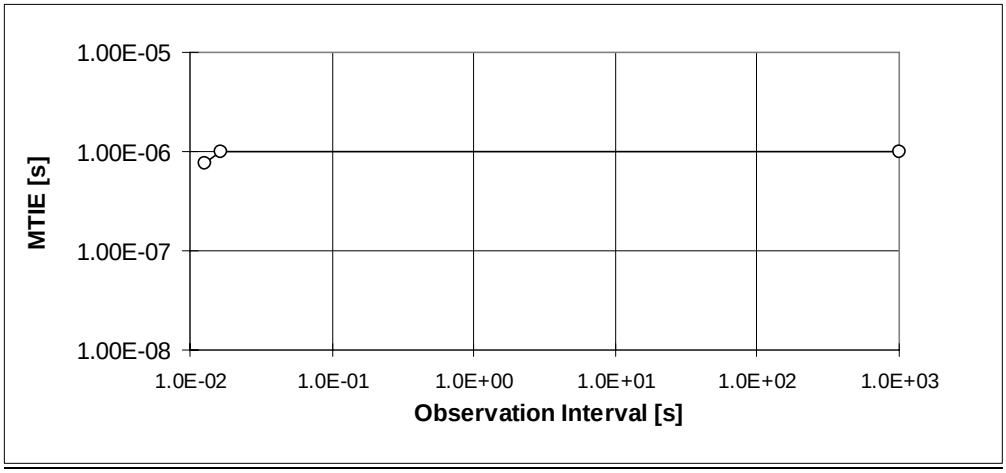
Object to which the specification applies: Synchronisation Supply Unit (SSU) Types V & VI

Specified quantity and measurement conditions: The phase transient response at the output of a Synchronisation Supply Unit of Type V or VI must meet this mask in cases of infrequent internal testing or rearrangement operations within the Synchronisation Supply Unit.

Mathematical description (as specified in the standard):

MTIE [ns]	Observation Interval [s]
61	$\tau \leq 0.001$
61 000 τ	$0.001 < \tau \leq 0.0164$
1000	$\tau > 0.0164$

Template (circles = points stored in the WinSTS template file):



Comments:

11.13 Wander Generation for SEC

11.13.1 SEC Option 1 at Constant Temperature

11.13.1.1 Expressed as MTIE

Standard: Draft ITU-T Recommendation G.813 (08/96)

File name: WANDER GENERATION SEC 1 G813.mti

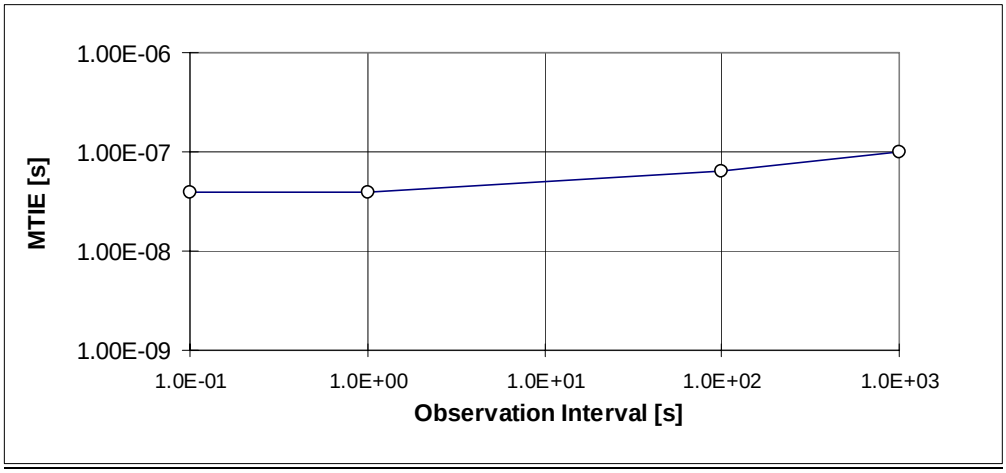
Object to which the specification applies: SDH Equipment Slave Clock (SEC) Option 1

Specified quantity and measurement conditions: The wander at the output of an SDH Equipment Slave Clock Option 1 must meet this mask when the input is connected to an ideal reference signal and when the ambient temperature is constant (+ 1 K).

Mathematical description (as specified in the standard):

MTIE [ns]	Observation Interval [s]
40	$0.1 < \tau \leq 1$
$40\ \tau^{0.1}$	$1 < \tau \leq 100$
$25.25\ \tau^{0.2}$	$100 < \tau \leq 1000$

Template (circles = points stored in the WinSTS template file):



Comments: For testing, the reference signal applied to the input of the clock must have a stability level that is at least 10 times better than the above output requirement.

11.13.1.2 Expressed as TDEV

Standard: Draft ITU-T Recommendation G.813 (08/96)

File name: WANDER GENERATION SEC 1 G813.tdv

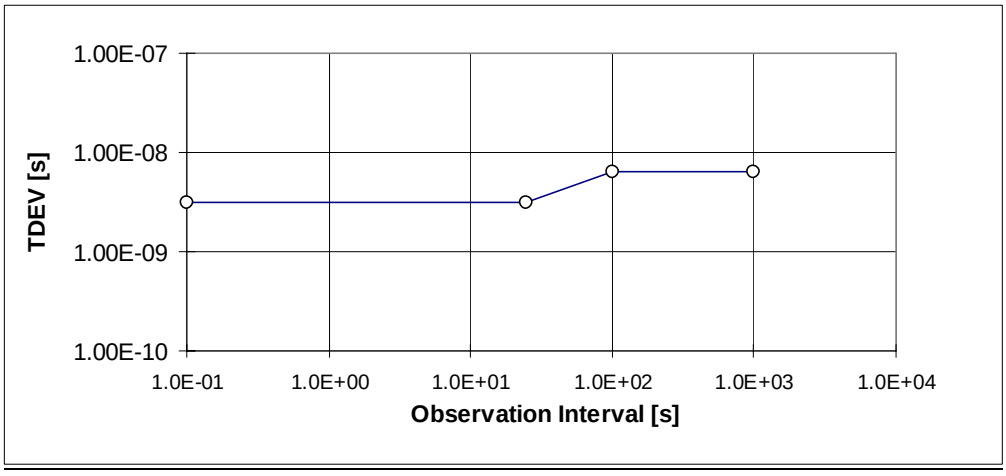
Object to which the specification applies: SDH Equipment Slave Clock (SEC) Option 1

Specified quantity and measurement conditions: The wander at the output of an SDH Equipment Slave Clock Option 1 must meet this mask when the input is connected to an ideal reference signal and when the ambient temperature is constant (± 1 K).

Mathematical description (as specified in the standard):

TDEV [ns]	Observation Interval [s]
3.2	$0.1 < \tau \leq 25$
$0.64\ \tau^{0.5}$	$25 < \tau \leq 100$
6.4	$100 < \tau \leq 1000$

Template (circles = points stored in the WinSTS template file):



Comments: For testing, the reference signal applied to the input of the clock must have a stability level that is at least 10 times better than the above output requirement.

11.13.2 SEC Option 1 at Variable Temperature

11.13.2.1 Expressed as MTIE

Standard: Draft ITU-T Recommendation G.813 (08/96)

File name: WANDER GEN VAR TEMP SEC 1 G813.mti

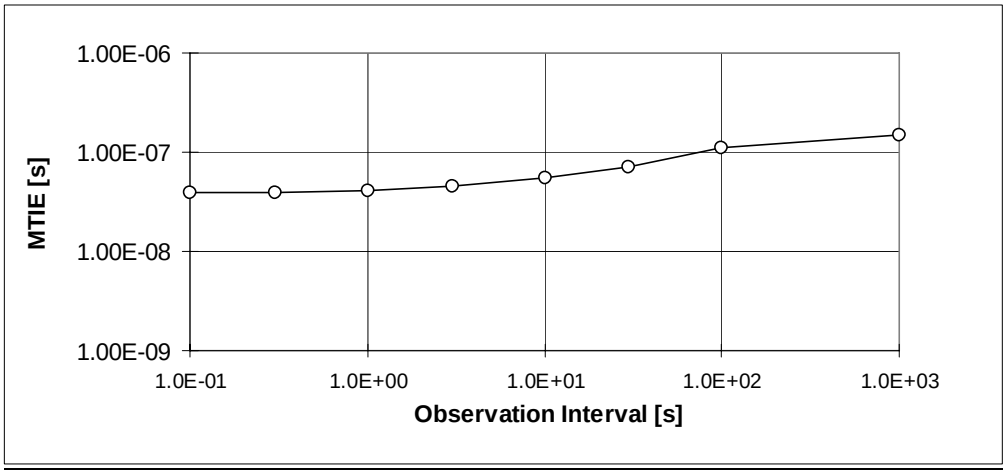
Object to which the specification applies: SDH Equipment Slave Clock (SEC) Option 1

Specified quantity and measurement conditions: The wander at the output of an SDH Equipment Slave Clock Option 1 must meet this mask when the input is connected to an ideal reference signal and signal and when the ambient temperature is variable (range and rate of change to be defined).

Mathematical description (as specified in the standard):

MTIE [ns]	Observation Interval [s]
$40 + 0.5\ \tau$	$0.1 < \tau \leq 1$
$40\ \tau^{0.1} + 0.5\ \tau$	$1 < \tau \leq 100$
$25.25\ \tau^{0.2} + 50$	$100 < \tau \leq 1000$

Template (circles = points stored in the WinSTS template file):



Comments: For testing, the reference signal applied to the input of the clock must have a stability level that is at least 10 times better than the above output requirement.

11.13.3 SEC Option 2 at Constant Temperature

11.13.3.1 Expressed as MTIE

Standard: Draft ITU-T Recommendation G.813 (08/96)

File name: WANDER GENERATION SEC 2 G813.mti

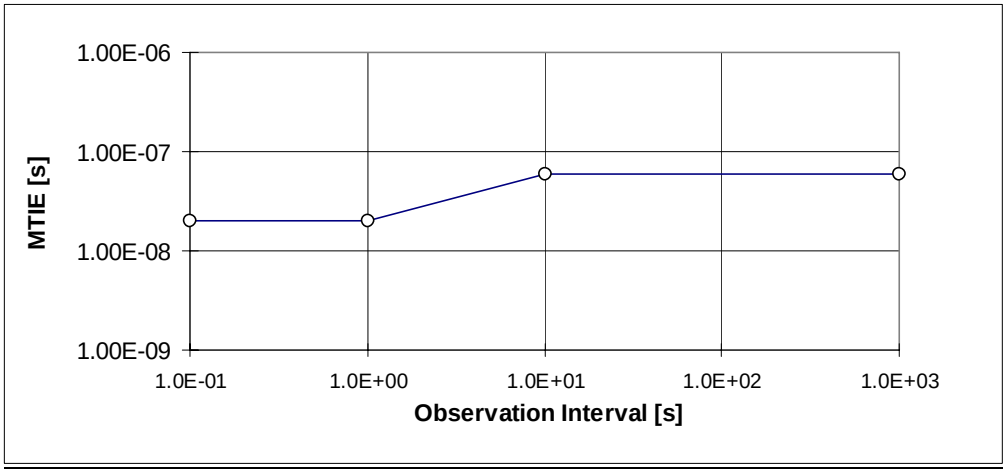
Object to which the specification applies: SDH Equipment Slave Clock (SEC) Option 2

Specified quantity and measurement conditions: The wander at the output of an SDH Equipment Slave Clock Option 2 must meet this mask when the input is connected to an ideal reference signal and when the ambient temperature is constant (± 1 K).

Mathematical description (as specified in the standard):

MTIE [ns]	Observation Interval [s]
20	$0.1 < \tau \leq 1$
$20\ \tau^{0.48}$	$1 < \tau \leq 10$
60	$10 < \tau \leq 1000$

Template (circles = points stored in the WinSTS template file):



Comments: For testing, the reference signal applied to the input of the clock must have a stability level that is at least 10 times better than the above output requirement.

11.13.3.2 Expressed as TDEV

Standard: Draft ITU-T Recommendation G.813 (08/96)

File name: WANDER GENERATION SEC 2 G813.tdv

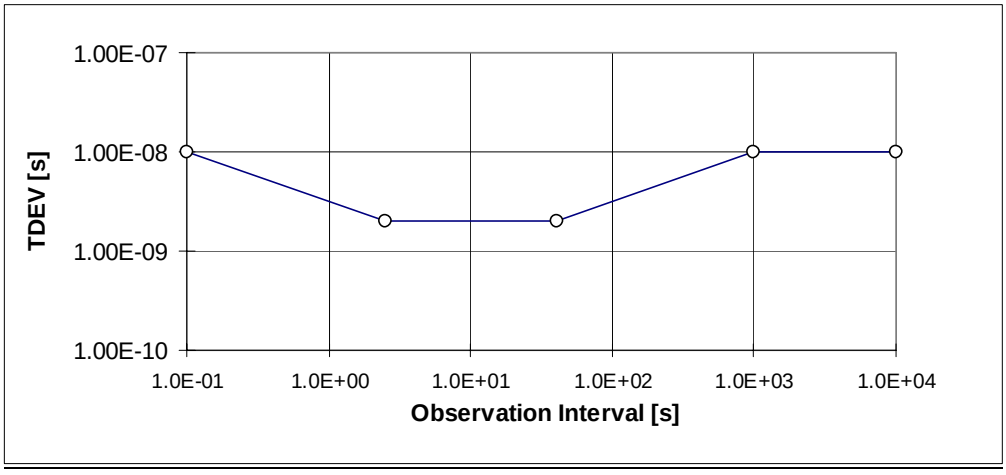
Object to which the specification applies: SDH Equipment Slave Clock (SEC) Option 2

Specified quantity and measurement conditions: The wander at the output of an SDH Equipment Slave Clock Option 2 must meet this mask when the input is connected to an ideal reference signal and when the ambient temperature is constant (± 1 K).

Mathematical description (as specified in the standard):

TDEV [ns]	Observation Interval [s]
$3.2\ \tau^{-0.5}$	$0.1 < \tau \leq 2.5$
2	$2.5 < \tau \leq 40$
$0.32\ \tau^{0.5}$	$40 < \tau \leq 1000$
10	$1000 < \tau \leq 10\ 000$

Template (circles = points stored in the WinSTS template file):



Comments: For testing, the reference signal applied to the input of the clock must have a stability level that is at least 10 times better than the above output requirement.

11.14 Noise Transfer for SEC

11.14.1 SEC Option 2 Expressed as TDEV

Standard: ITU-T Recommendation G.813 (08/96)

File name: NOISE TRANSFER SEC 2 G813.mti

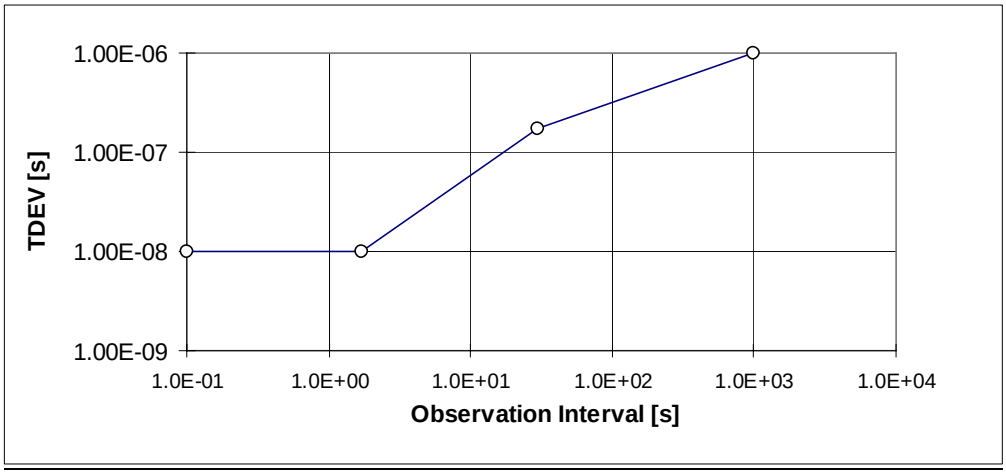
Object to which the specification applies: SDH Equipment Slave Clock (SEC) Option 2

Specified quantity and measurement conditions: The wander at the output of an SDH Equipment Slave Clock Option 2 must meet this mask when the input reference has a TDEV that is equal to the Wander Tolerance specification.

Mathematical description (as specified in the standard):

TDEV [ns]	Observation Interval [s]
10	$0.1 < \tau \leq 1.7$
$5.77\ \tau$	$1.7 < \tau \leq 30$
$31.63\ \tau^{0.5}$	$30 < \tau \leq 1000$

Template (circles = points stored in the WinSTS template file):



Comments: Wander Tolerance (TDEV) for SSU Type I in Draft ITU-T Rec. G.812 (09/97):

TDEV [ns]	Observation Interval [s]
17	$0.05 < \tau \leq 3$
$5.77\ \tau$	$3 < \tau \leq 30$
$31.63\ \tau^{0.5}$	$30 < \tau \leq 1000$

11.15 Short-term Phase Transient Response for SEC

11.15.1 SEC Option 2 Expressed as MTIE

Standard: ITU-T Recommendation G.813 (08/96)

File name: SHORT TRANSIENT SEC 2 G813.mti

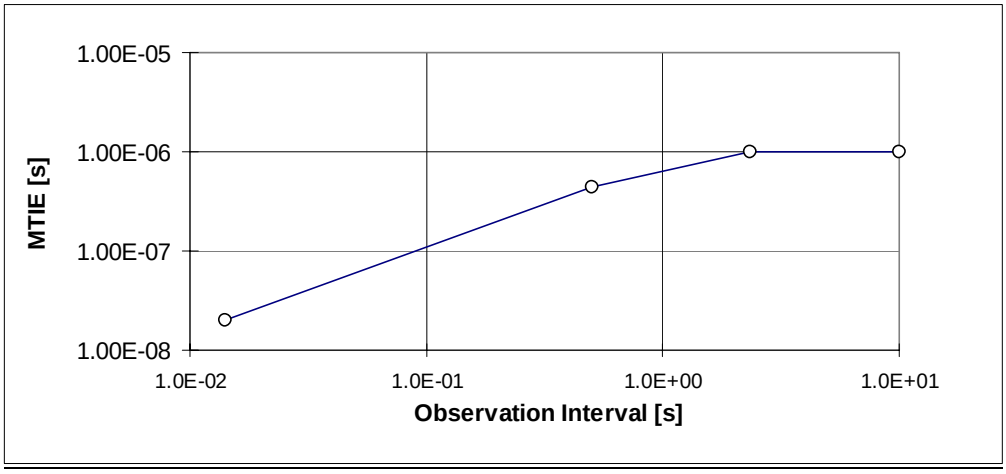
Object to which the specification applies: SDH Equipment Slave Clock (SEC) Option 2

Specified quantity and measurementcConditions: The phase transient response at the output of an SDH Equipment Slave Clock Option 2 must meet this mask when the currently selected input reference is lost and a second reference, traceable to the same reference clock, is selected instead.

Mathematical description (as specified in the standard):

MTIE	Observation Interval
Not specified	$\tau \leq 0.014$
$7.6 + 885\ \tau$	$0.014 < \tau \leq 0.5$
$300 + 300\ \tau$	$0.5 < \tau \leq 2.33$
1000	$\tau > 2.33$

Template (circles = points stored in the WinSTS template file):



Comments:

11.16 Long-term Phase Transient Response (holdover) for SEC

11.16.1 SEC Option 2 Expressed as MTIE

Standard: ITU-T Recommendation G.813 (08/96)

File name: HOLDOVER TRANSIENT SEC 2 G813.mti

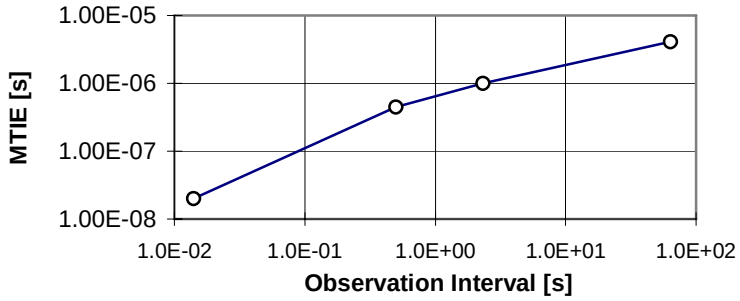
Object to which the specification applies: SDH Equipment Slave Clock (SEC) Option 2

Specified quantity and measurement conditions: The phase transient response of an SDH Equipment Slave Clock Option 2 occuring upon entry into holdover mode must meet this mask.

Mathematical description (as specified in the standard):

MTIE [ns]	Observation Interval [s]
Not specified	$\tau \leq 0.014$
7.6 + 885 τ	$0.014 < \tau \leq 0.5$
300 + 300 τ	$0.5 < \tau \leq 2.33$
884 + 50 τ	$2.33 < \tau \leq 64$
Not specified	$\tau > 64$

Template (circles = points stored in the WinSTS template file):



Comments: Besides meeting this MTIE mask, the long-term phase transient response (holdover) of a SEC Option 2 must also comply with the following specifications (at constant temperature):

- Initial fractional frequency offset in the first minute after the first 64 s < 0.05 ppm
- Frequency drift < 5.8E-6 ppm/s

This page has been intentionally left blank

Chapter

12 Application Note

Including :

- Introduction
- Formulas
- Equipment Noise Measurement
- Measurement Data Interpretation
- Measurement Samples

This page has been intentionally left blank

12.1 Introduction

Evaluating Measurement Data to Determine the Effect of Different Noise Sources Generated by Clock Signals

The Synchronisation Test Set (STS), OSA model 5565, performs phase measurements (Time Interval Error) between an input signal and its internal high stability Rubidium reference. Measurement resolution is 100 ps.

To facilitate the interpretation of the measurements, measurement data is processed by the STS software and can be viewed using criteria specified by the industry standards - MTIE, TDEV, ADEV, MADEV and frequency error.

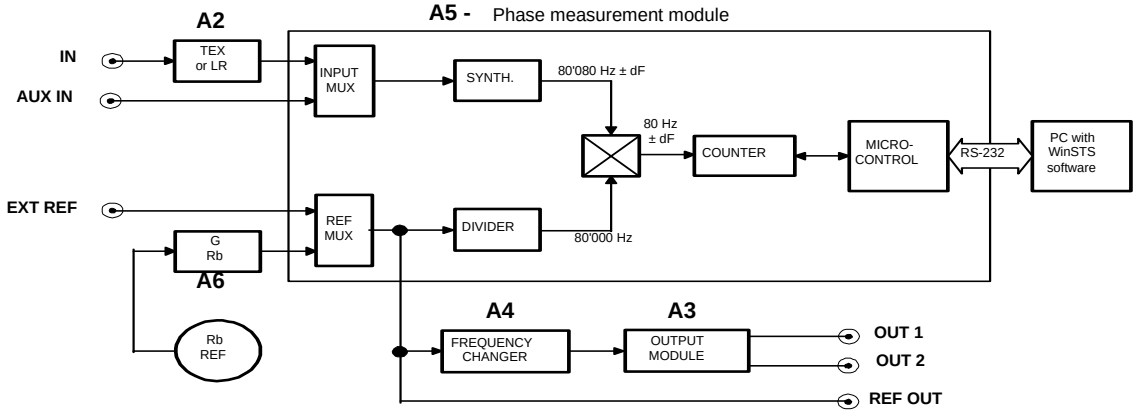


Figure 12-1 : STS 5565 Block Diagram

12.2 Formulas

12.2.1 TIE (Time Interval Error)

$\mathbf{x}_i = \mathbf{x}(i\tau_0)$	TIE for time $t = i\tau_0$
i	measurement number i = 1, 2, ...,N
τ_0	sampling time
$n\tau_0$	observation period

12.2.2 MTIE (Maximum Time Interval Error)

$$MTIE(n\tau_0) = \max_{1\le k\le N-n}\left[\max_{k\le i\le k+n} x(i) - \min_{k\le i\le k+n} x(i)\right]$$

12.2.3 ADEV (Allan DEViation)

$$ADEV(n\tau_0) = \sqrt{\frac{1}{2n^2\tau_0^2(N-2n)}\sum_{i=1}^{N-2n}(x_{i+2n} - 2x_{i+n} + x_i)^2}$$

12.2.4 MADEV or MDEV (Modified Allan DEViation)

$$MADEV(n\tau_0) = \sqrt{\frac{1}{2n^4\tau_0^2(N-3n+1)}\sum_{j=1}^{N-3n+1}\left[\sum_{i=j}^{n+j-1}(x_{i+2n} - 2x_{i+n} + x_i)\right]^2}$$

12.2.5 TDEV (Time DEViation)

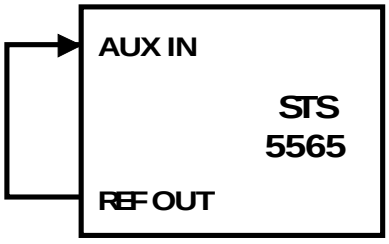
$$TDEV(n\tau_0) = \sqrt{\frac{1}{6n^2(N-3n+1)}\sum_{j=1}^{N-3n+1}\left[\sum_{i=j}^{n+j-1}(x_{i+2n} - 2x_{i+n} + x_i)\right]^2}$$

12.3 Equipment Noise Measurement

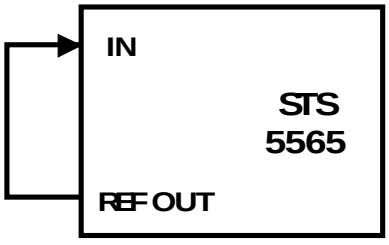
The goal of these measurements is to determine the effect of the different sources of noise generated by the equipment.

As seen in the illustrations below, the measurements on both the input and output interfaces are made against the same source - the equipment's internal high stability Rubidium.

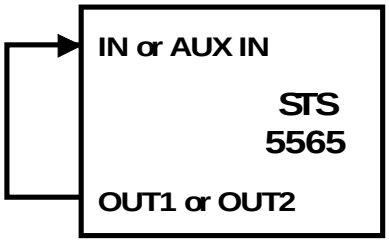
12.3.1 Phase Measurement Module



12.3.2 Input Interface Unit



12.3.3 Output Interface Uni



***Note*:**

If the output is a framed signal, e.g. HDB3, the appropriate input card must be fitted to the equipment, e.g. 2.048 Mbit/s Input Interface Unit.

12.3.4 Evaluation

The results obtained from the measurements made above will determine the lower measurement limit of the OSA 5565 Synchronisation Test Set.

It is thus important to take this limit into account when making measurements to establish if the significance of these limits on the measurements.

A typical measurement of the equipment's noise using the configuration in 4.1 is given in the attached print-outs.

12.4 Measurement Data Interpretation

The reason for making measurements with the OSA 5565 is to determine the quality of synchronisation references or to identify the factors that degrade a reference signal.

In an ideal case, comparison against masks defined by the industry standards and an understanding of the system noise are sufficient criteria for acceptance of the measurement results.

However, it is often the case that undesirable, measurable or pseudo-random, affect the measurement and masks the normal behaviour of the sources or measured elements. It is therefore useful to separate the different factors contributing to this and to determine their cause.

The tables below show the relationship between the type of perturbation and its effect on the relevant parameter, MTIE or TDEV.

x (t)	**MTIE (τ)**
Initial phase offset $\mathbf{x}_o$	= 0
Initial frequency offset $\mathbf{y}_o$	= $\mathbf{y}_o$ x τ
Frequency ageing **D**	= **D** ($\mathbf{t}_{max}$ x τ - τ^2 / **2**)
Phase jump Δ**x**	= Δ**x** for all values of $\tau > \tau_0$
Sinusoidal Phase Modulation **A**sin ($2\pi n\tau_0$/**T**)	= **2** x **A** for $\tau >$ **T** / 2
White Phase Noise **WPM**	Depends on the distribution of the amplitude
Phase Flicker Noise **FPM**	
White frequency Noise **WFM**	
Frequency Flicker Noise **FFM**	
Frequency Random Walk **RFM**	

Table 12-1 Perturbation Effects on MTIE

x (t)	TDEV (τ)
Initial phase offset $\mathbf{x_o}$	= **0**
Initial frequency offset $\mathbf{y_o}$	= **0**
Frequency ageing **D**	= (**D** / $\sqrt{\mathbf{6}}$) x τ^2
Phase jump Δ**x**	See simulation attached
Sinusoidal Phase Modulation **A**sin ($2\pi n\tau_0$/**T**)	See simulation attached
White Phase Noise **WPM**	Proportional to $\tau^{-1/2}$
Phase Flicker Noise **FPM**	Proportional to τ^{0}
White frequency Noise **WFM**	Proportional to $\tau^{1/2}$
Frequency Flicker Noise **FFM**	Proportional to τ^{1}
Frequency Random Walk **RFM**	Proportional to $\tau^{3/2}$

Table 12-2 Perturbation Effects on TDEV

x (t)	ADEV (τ)
Initial phase offset $\mathbf{x_o}$	= **0**
Initial frequency offset $\mathbf{y_o}$	= **0**
Frequency ageing **D**	= (**D** / $\sqrt{\mathbf{2}}$) x τ
Phase jump Δ**x**	See simulation attached
Sinusoidal Phase Modulation **A**sin ($2\pi n\tau_0$/**T**)	See simulation attached
White Phase Noise **WPM**	Proportional to τ^{-1}
Phase Flicker Noise **FPM**	Proportional to τ^{-1}
White frequency Noise **WFM**	Proportional to $\tau^{-1/2}$
Frequency Flicker Noise **FFM**	Proportional to τ^{0}
Frequency Random Walk **RFM**	Proportional to $\tau^{1/2}$

Table 12-3 Perturbation Effects on ADEV

x (t)	MADEV (τ)
Initial phase offset $\mathbf{x_o}$	= **0**
Initial frequency offset $\mathbf{y_o}$	= **0**
Frequency ageing **D**	= (**D** / $\sqrt{\mathbf{2}}$) x τ
Phase jump Δ**x**	See simulation attached
Sinusoidal Phase Modulation **A**sin ($2\pi n\tau_0$/**T**)	See simulation attached
White Phase Noise **WPM**	Proportional to $\tau^{-3/2}$
Phase Flicker Noise **FPM**	Proportional to τ^{-1}
White frequency Noise **WFM**	Proportional to $\tau^{-1/2}$
Frequency Flicker Noise **FFM**	Proportional to τ^{0}
Frequency Random Walk **RFM**	Proportional to $\tau^{1/2}$

Table 12-4 Perturbation Effects on MADEV

12.5 Measurement Samples

The following graphs represent the result of various simulations made from acquisitions of 2000 points.

The comparison of the simple cases shows the theoretical behaviour described in the above tables as well as the influence of the measurable events.

12.5.1 System Noise (TIE)

Measurement: 10000 x 12.5 milliseconds
Comments: input AUX from REFOUT

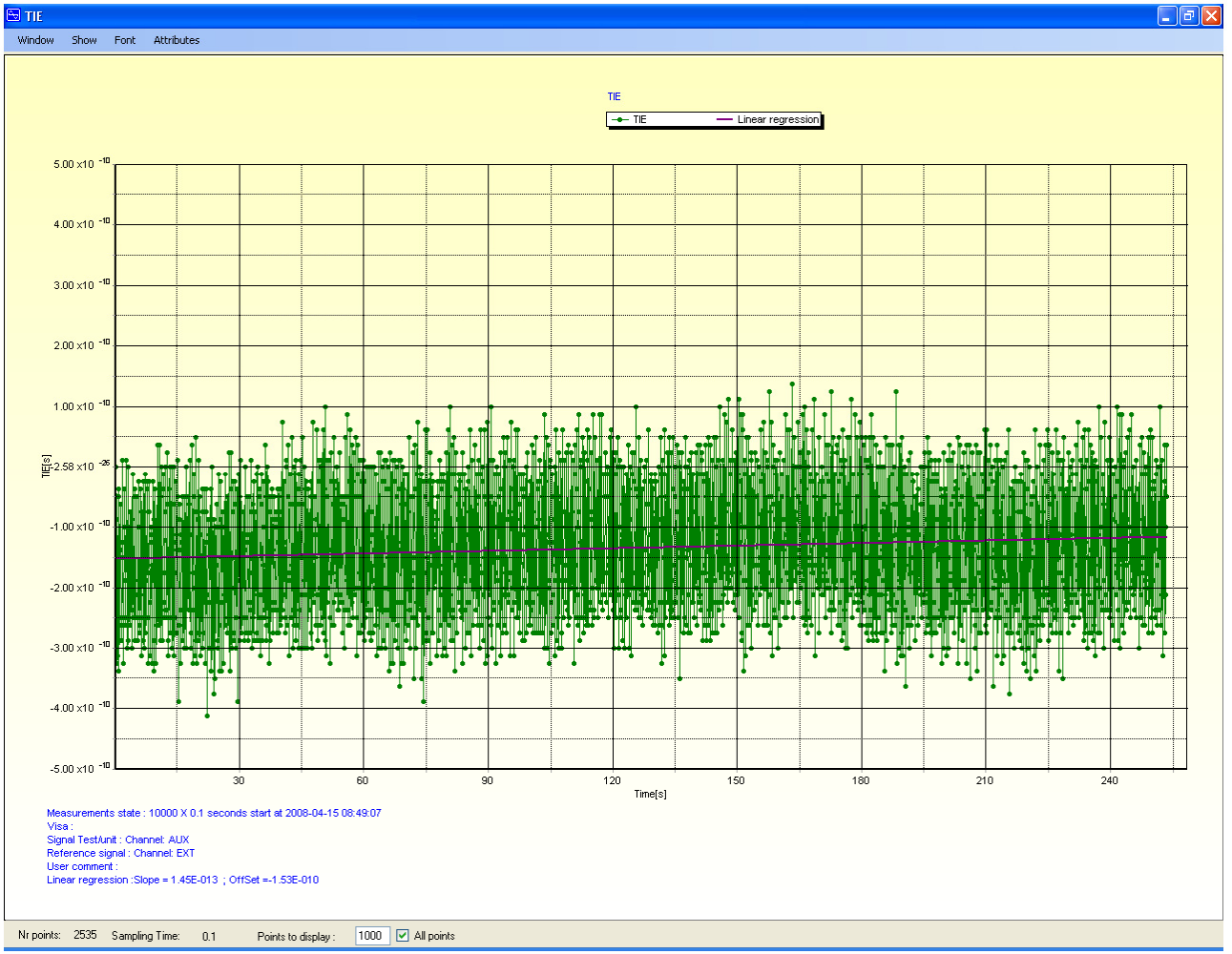


Figure 12-2 : System Noise (TIE)

12.5.2 System Noise (MTIE)

Measurement: 10000 x 12.5 milliseconds
Comments: input AUX from REFOUT

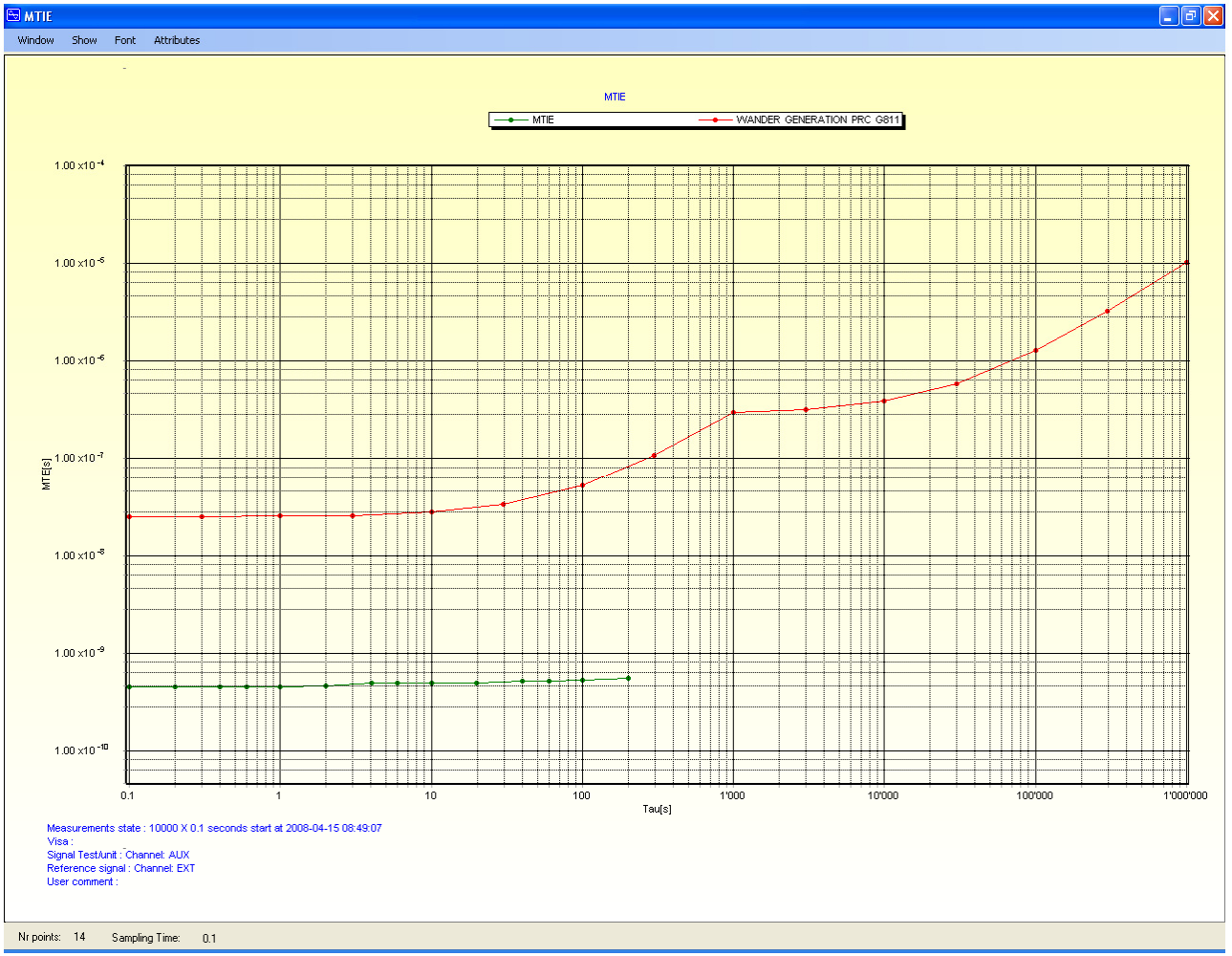


Figure 12-3 : System Noise (MTIE)

12.5.3 System Noise (MADEV)

Measurement: 10000 x 12.5 milliseconds
Comments: input AUX from REFOUT

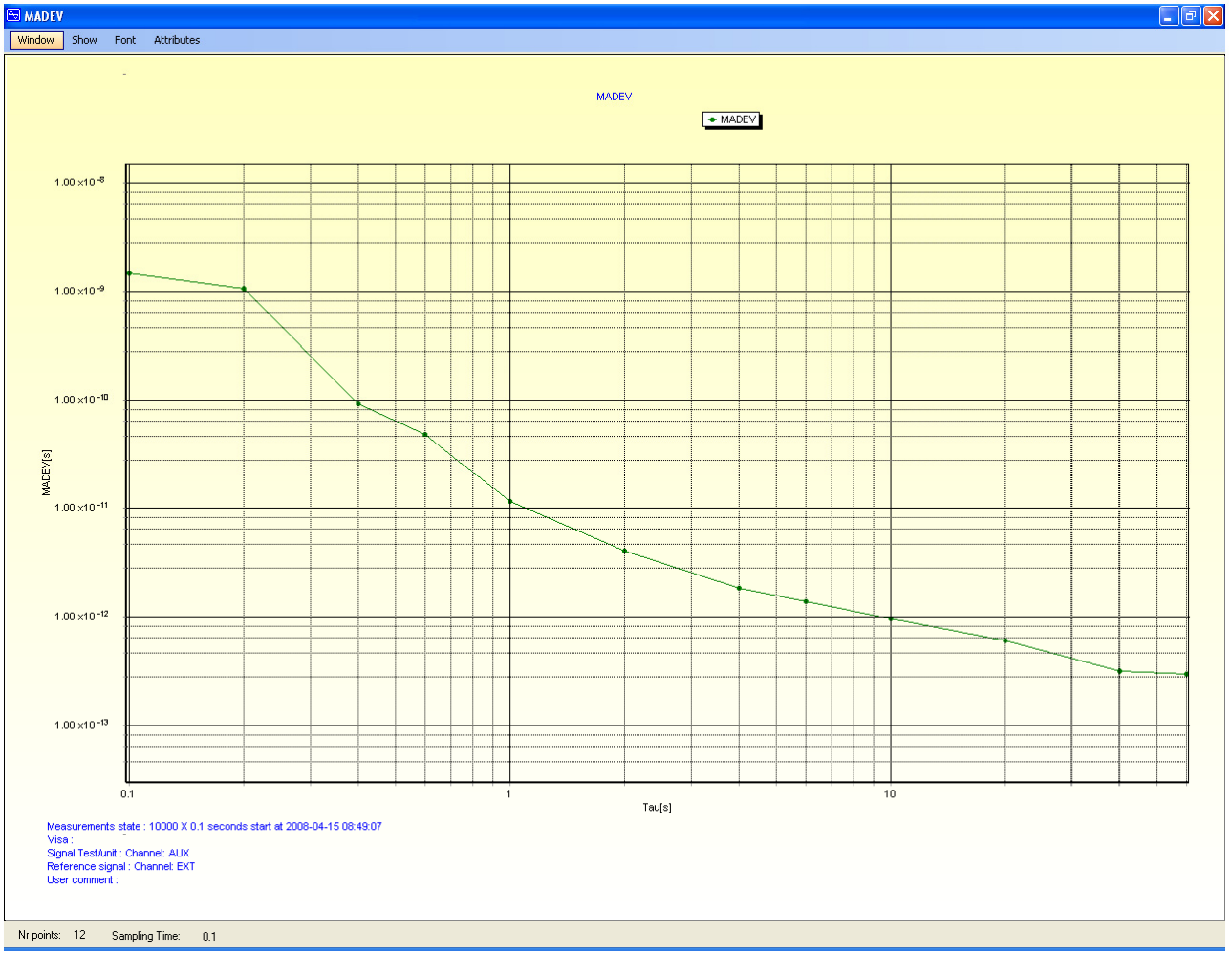


Figure 12-4 : System Noise (MADEV) Sample

12.5.4 System Noise (TDEV)

Measurement: 10000 x 12.5 milliseconds
Comments: input AUX from REFOUT

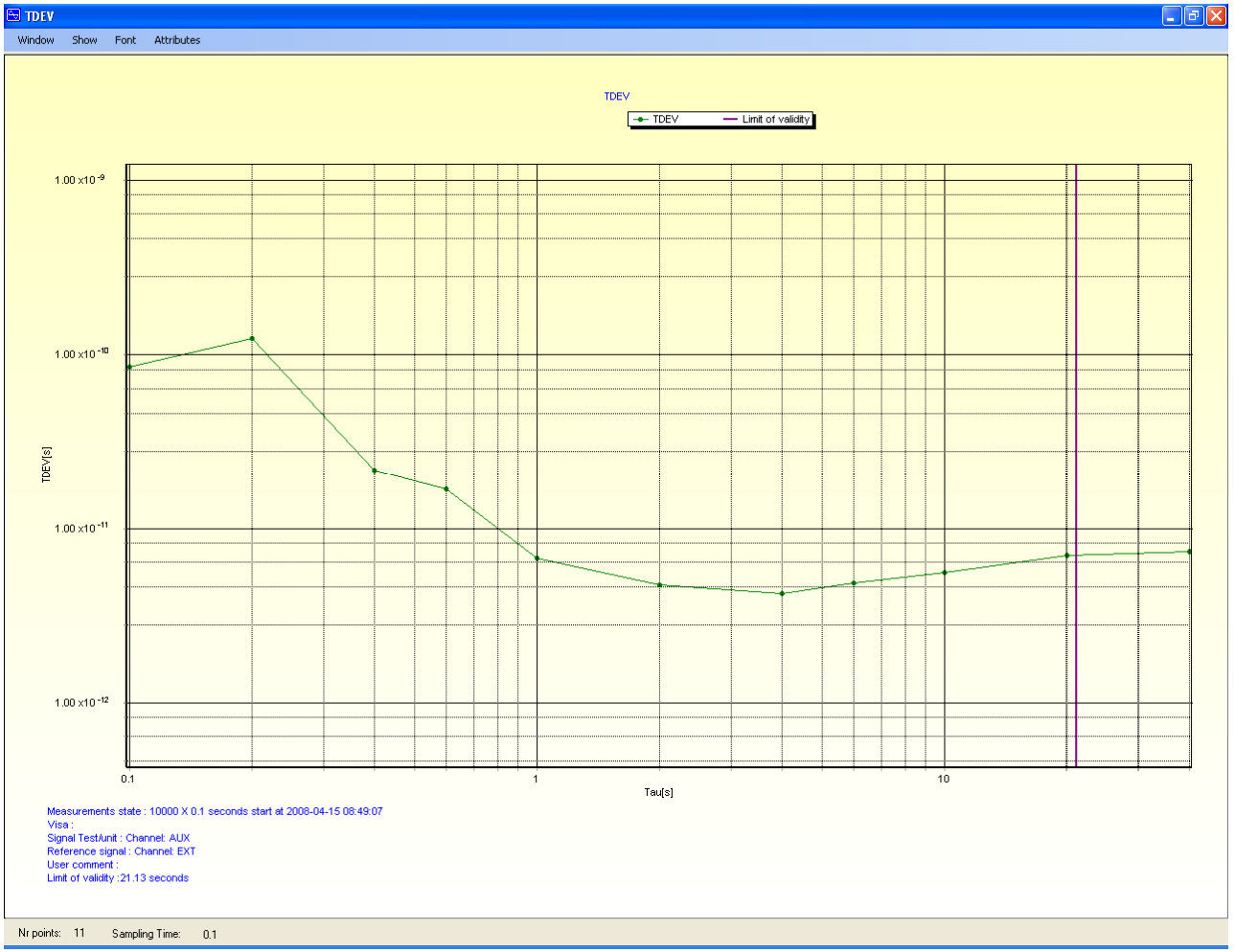


Figure 12-5 : System Noise (TDEV)

12.5.5 System Noise (ADEV)

Measurement: 10000 x 12.5 milliseconds
Comments: input AUX from REFOUT

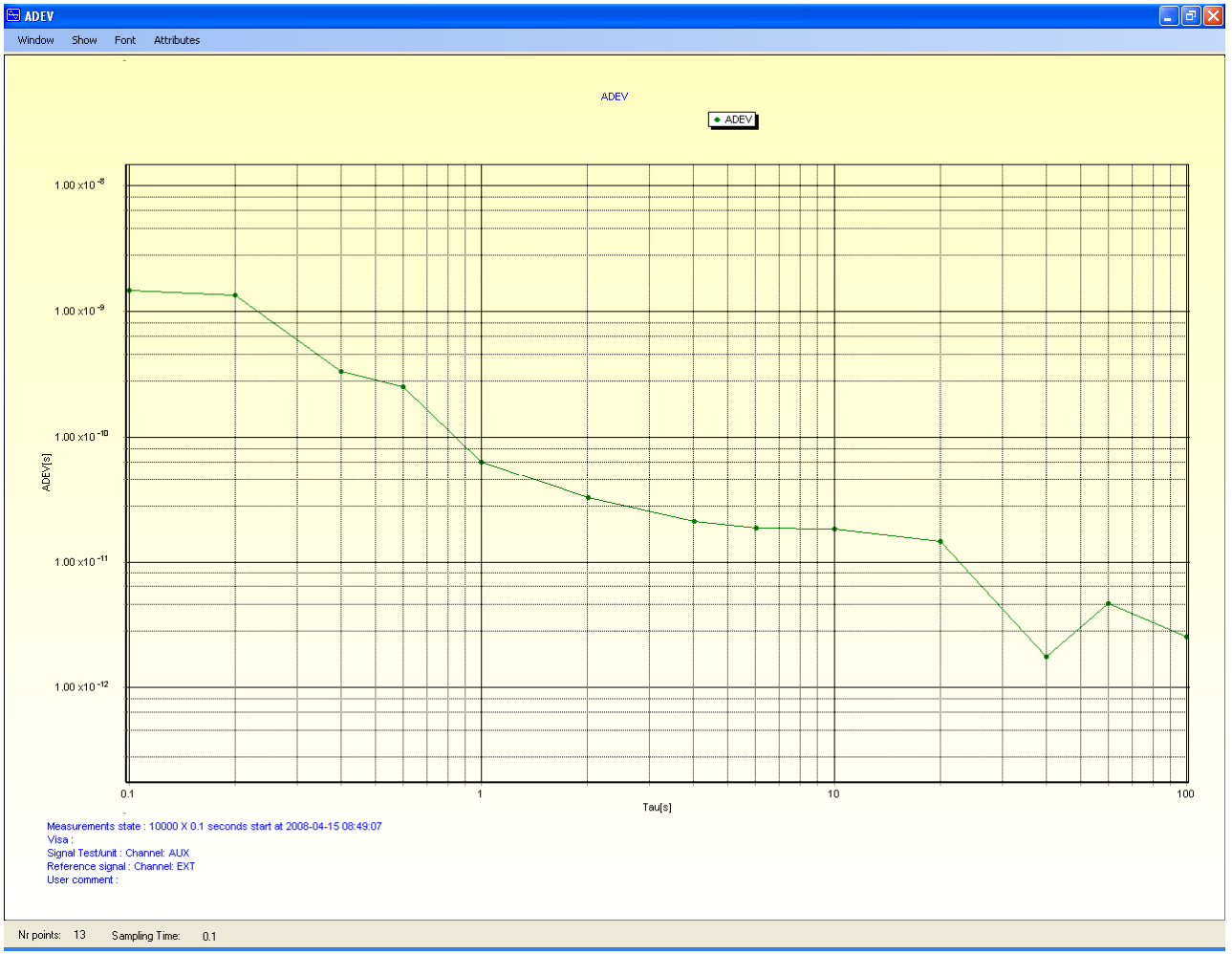


Figure 12-6 : System Noise (ADEV)

12.5.6 White Phase Modulation (TIE)

Measurement: 2000 x 1 second(s)
Comments: simulated

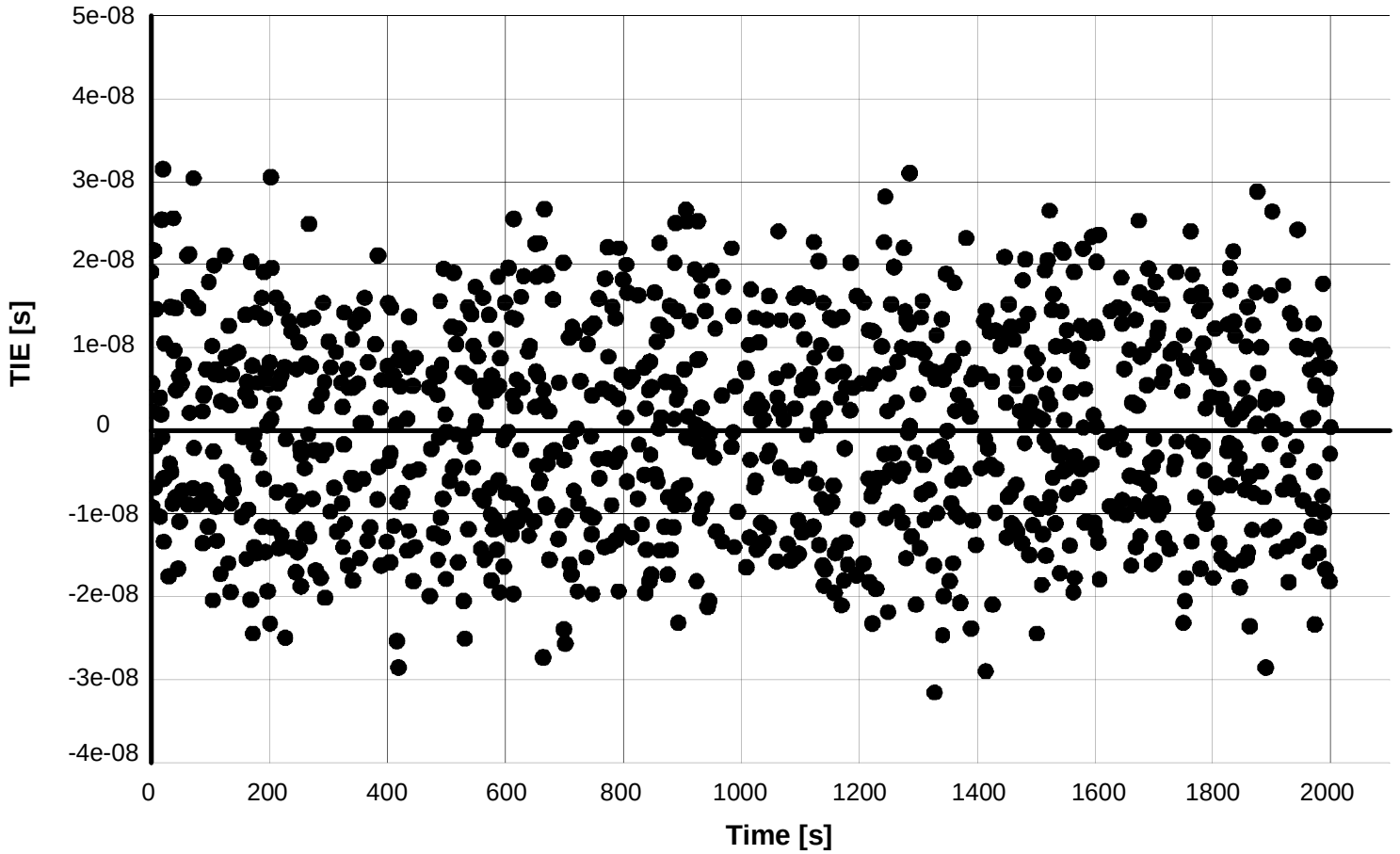


Figure 12-7 : White Phase Modulation (TIE)

12.5.7 White Phase Modulation (MTIE)

Measurement: 2000 x 1 second(s)
Comments: simulated

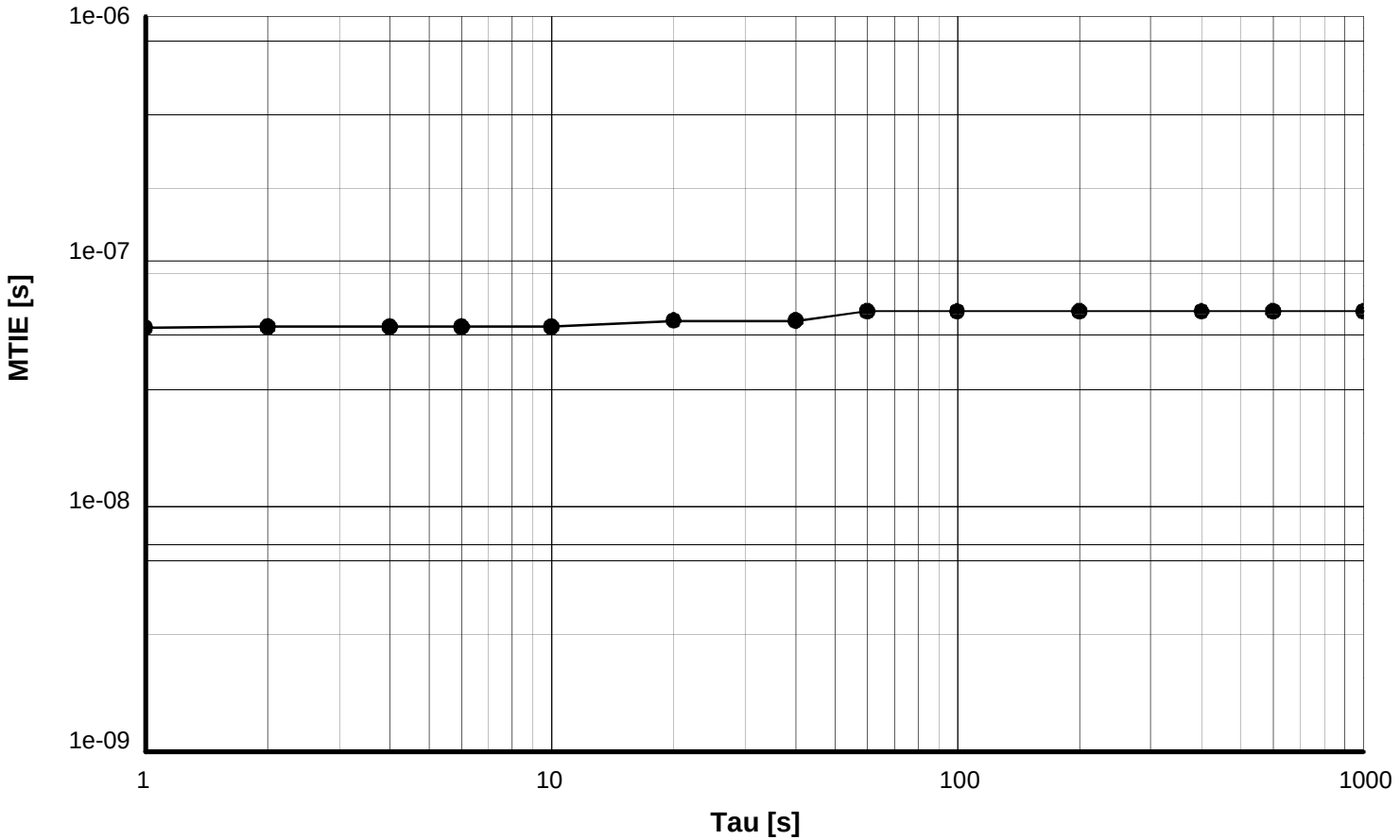


Figure 12-8 : White Phase Modulation (TIE)

12.5.8 White Phase Modulation (MADEV)

Measurement: 2000 x 1 second(s)
Comments: simulated

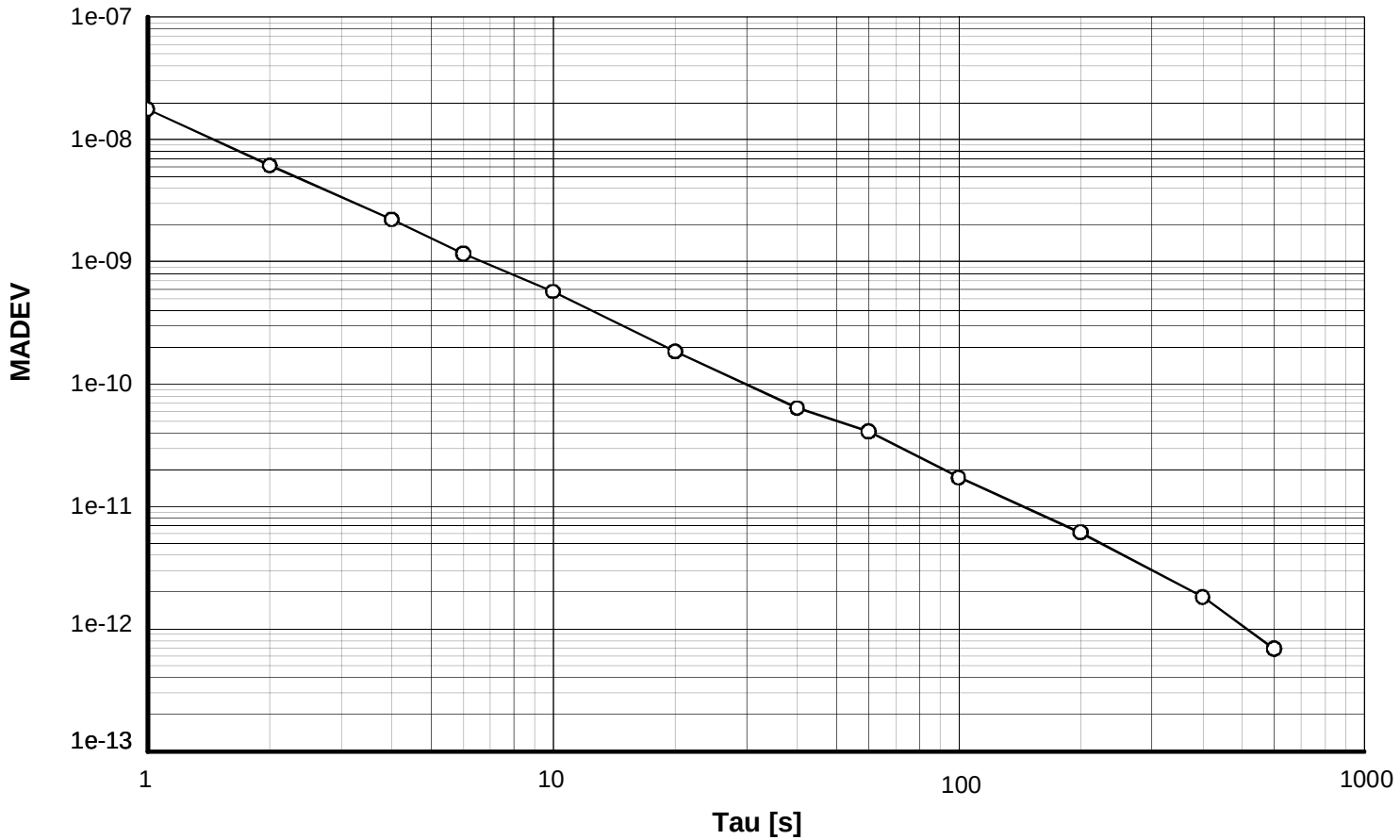


Figure 12-9 : White Phase Modulation (MADEV)

12.5.9 White Phase Modulation (TDEV)

Measurement: 2000 x 1 second(s)
Comments: simulated

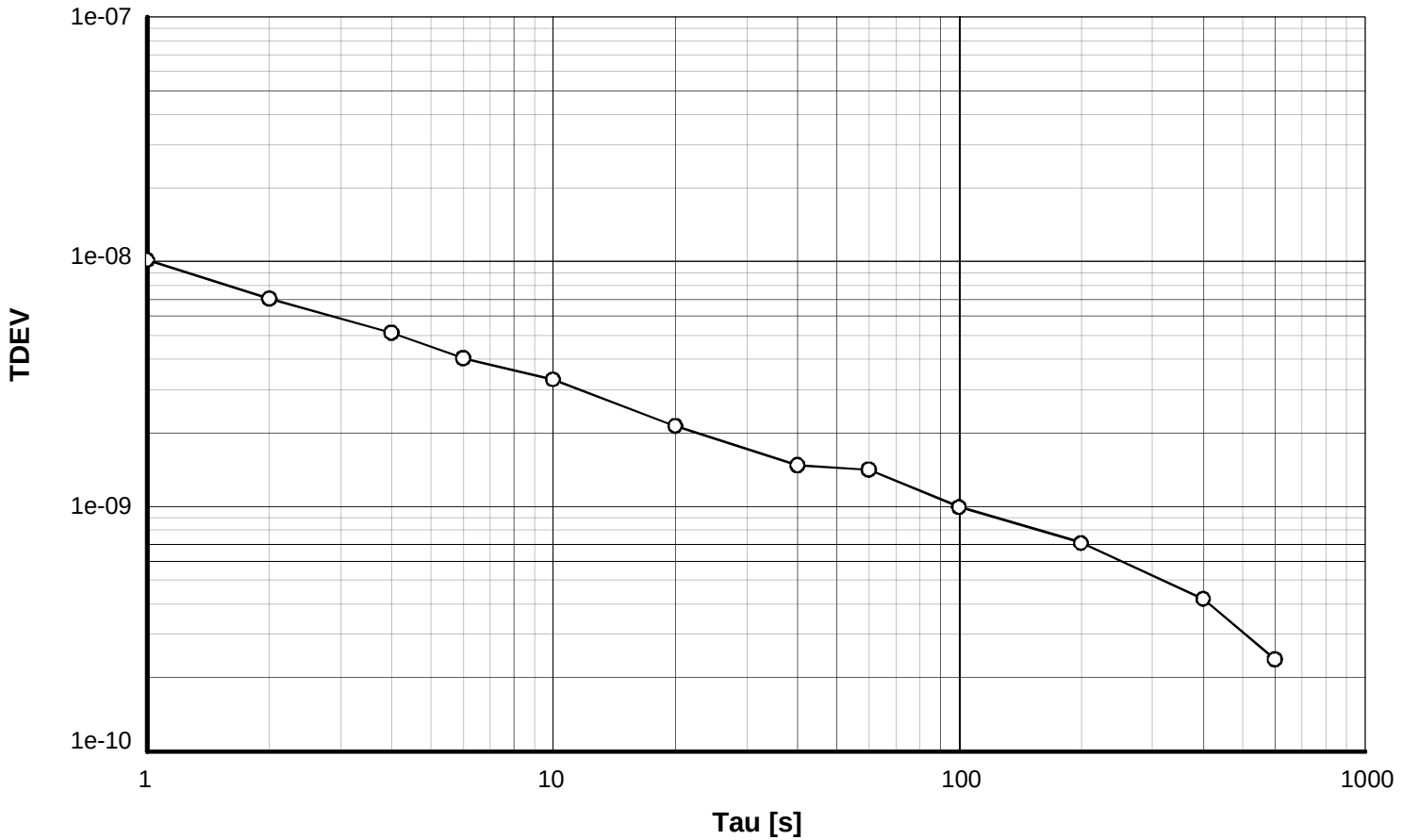


Figure 12-10 : White Phase Modulation (TDEV)

12.5.10 White Phase Modulation (ADEV)

Measurement: 2000 x 1 second(s)
Comments: simulated

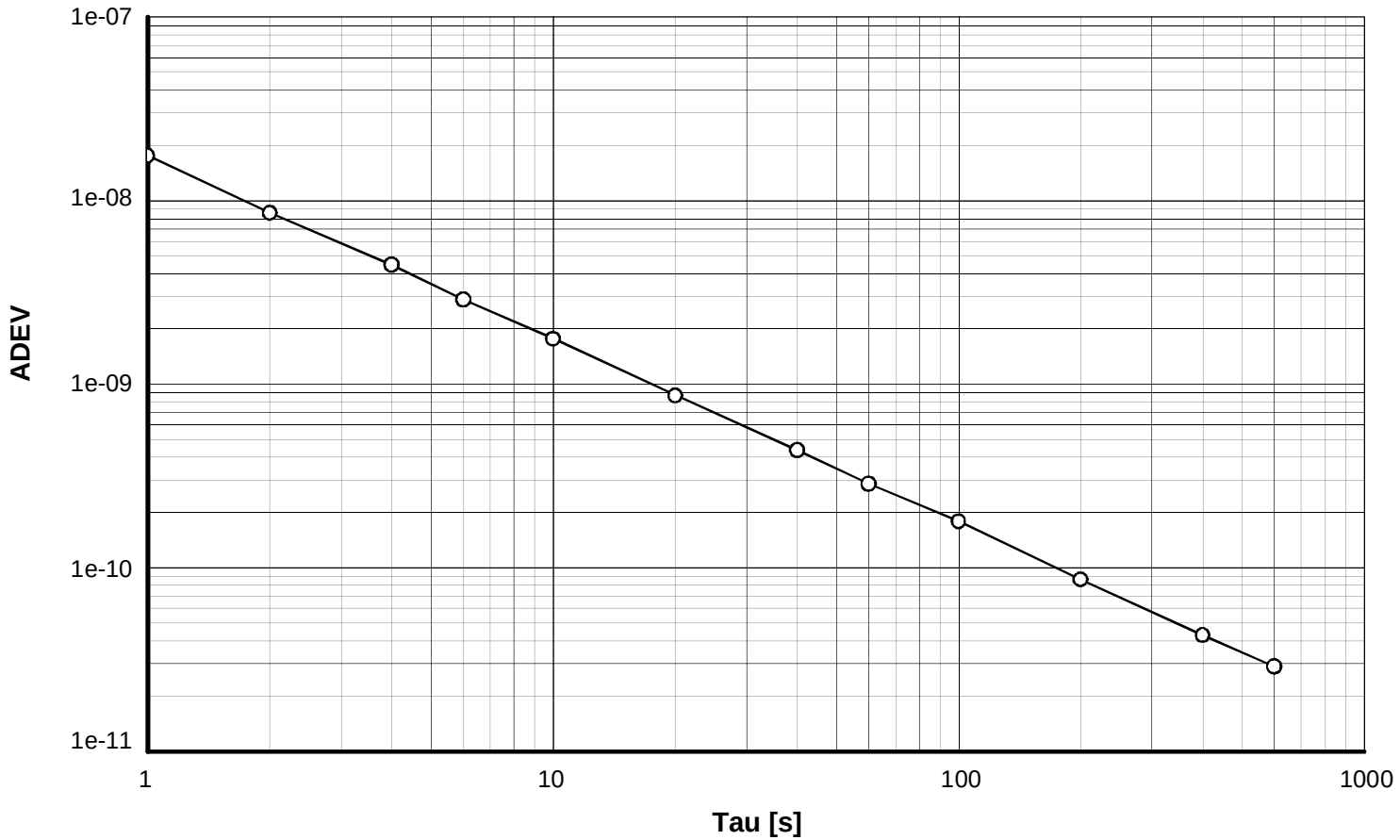


Figure 12-11 : White Phase Modulation (ADEV)

12.5.11 Flicker Phase Modulation (TIE)

Measurement: 2000 x 1 second(s)
Comments: simulated

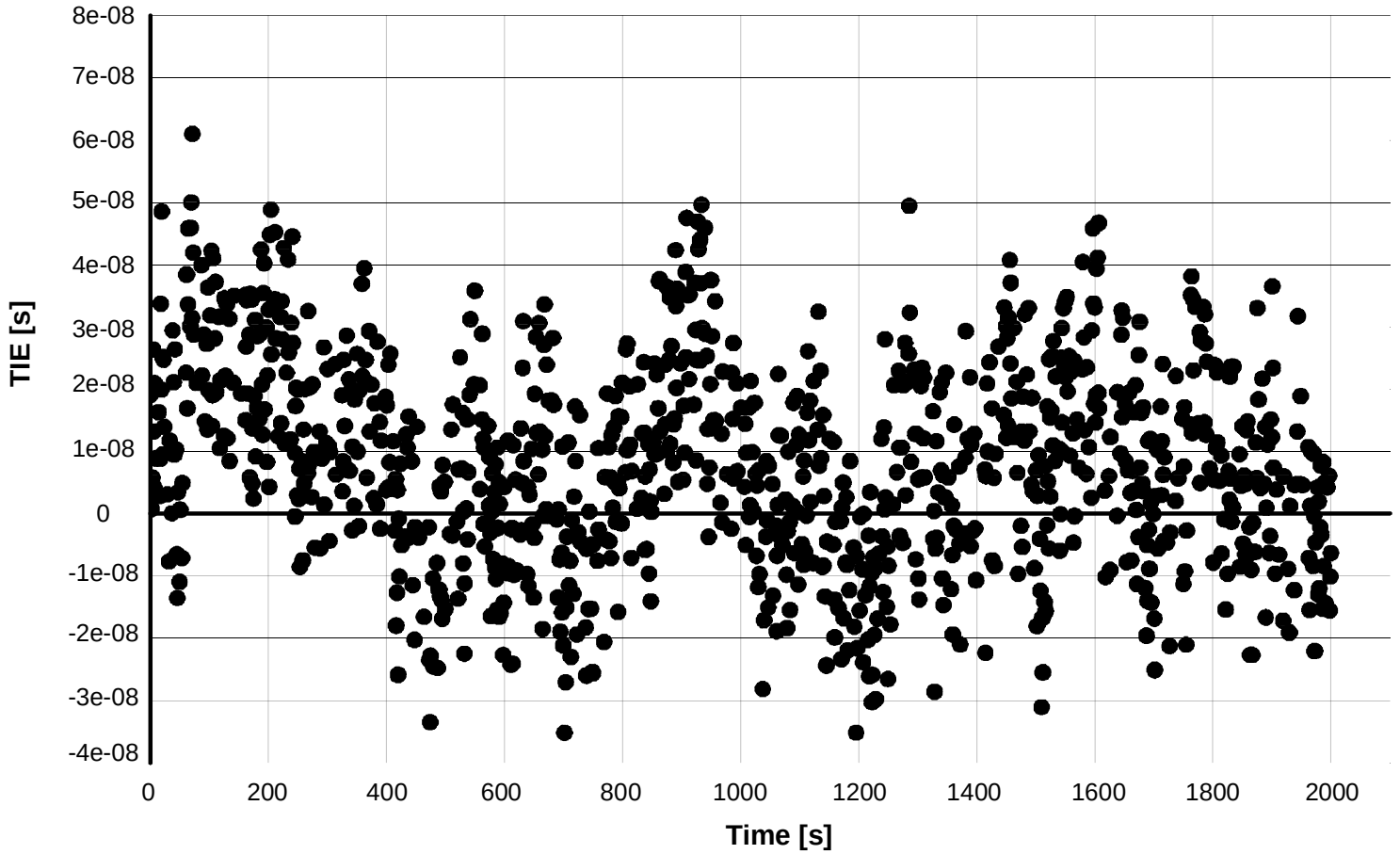


Figure 12-12 : Flicker Phase Modulation (TIE)

12.5.12 Flicker Phase Modulation (MTIE)

Measurement: 2000 x 1 second(s)
Comments: simulated

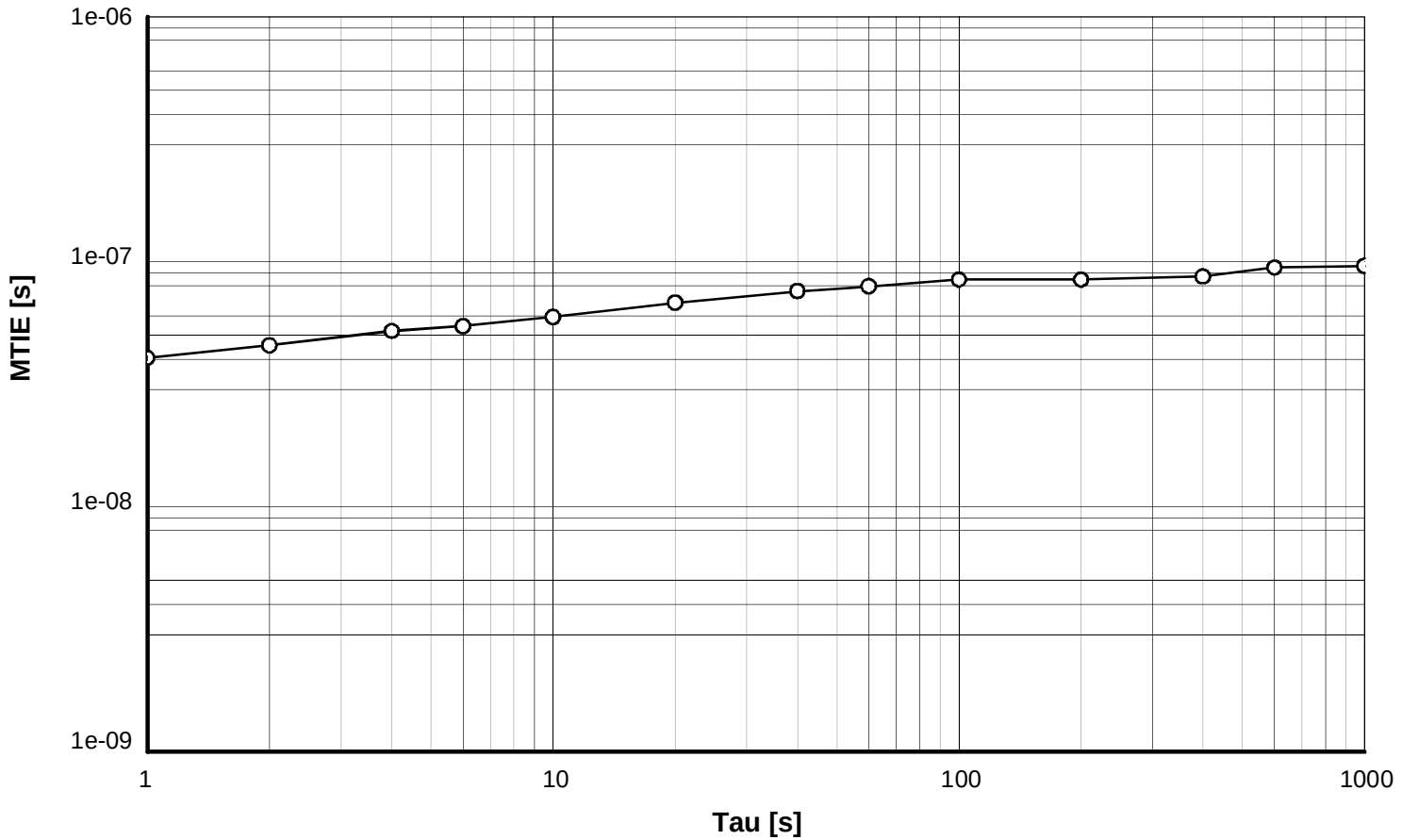


Figure 12-13 : Flicker Phase Modulation (MTIE)

12.5.13 Flicker Phase Modulation (MADEV)

Measurement: 2000 x 1 second(s)
Comments: simulated

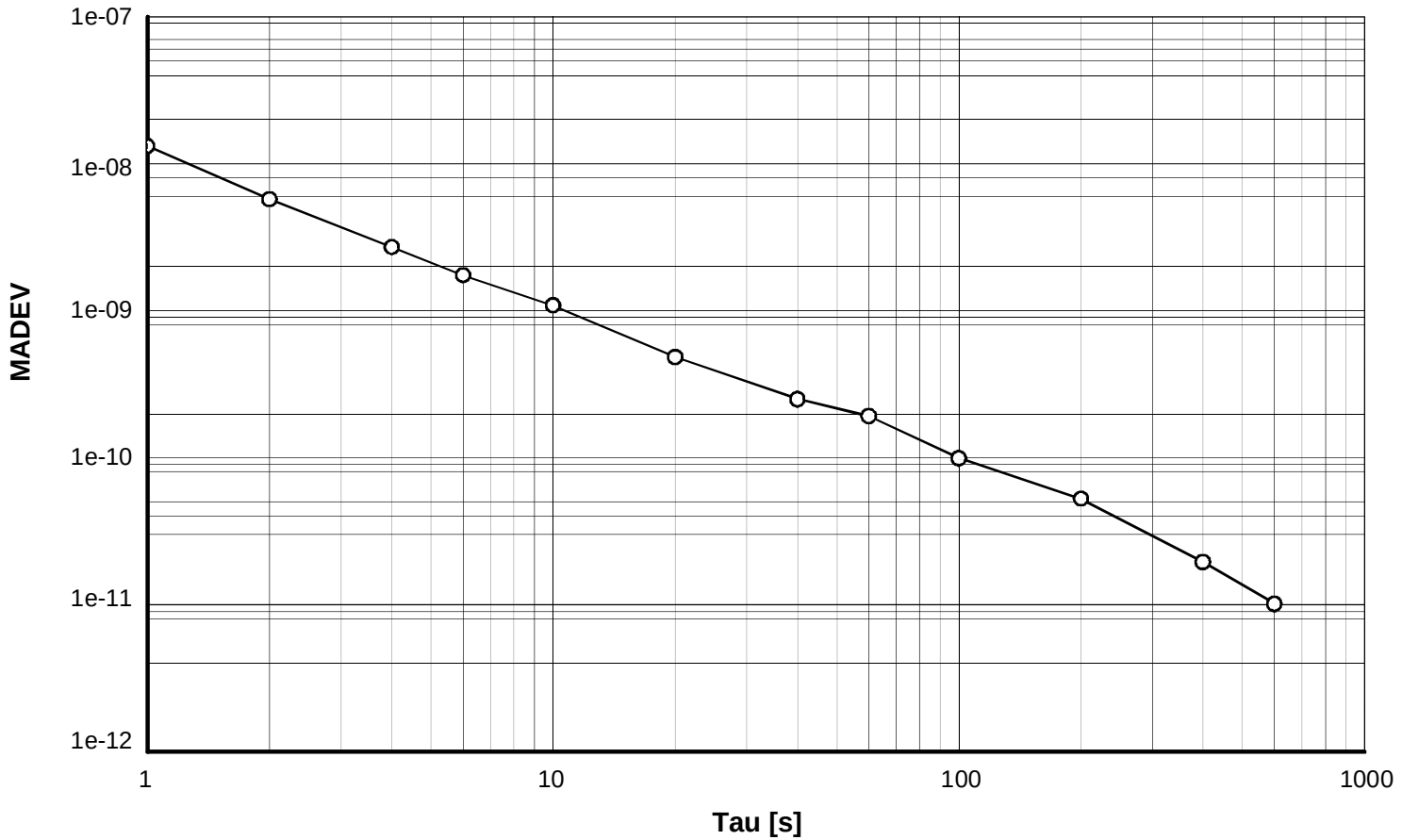


Figure 12-14 : Flicker Phase Modulation (MADEV)

12.5.14 Flicker Phase Modulation (TDEV)

Measurement: 2000 x 1 second(s)
Comments: simulated

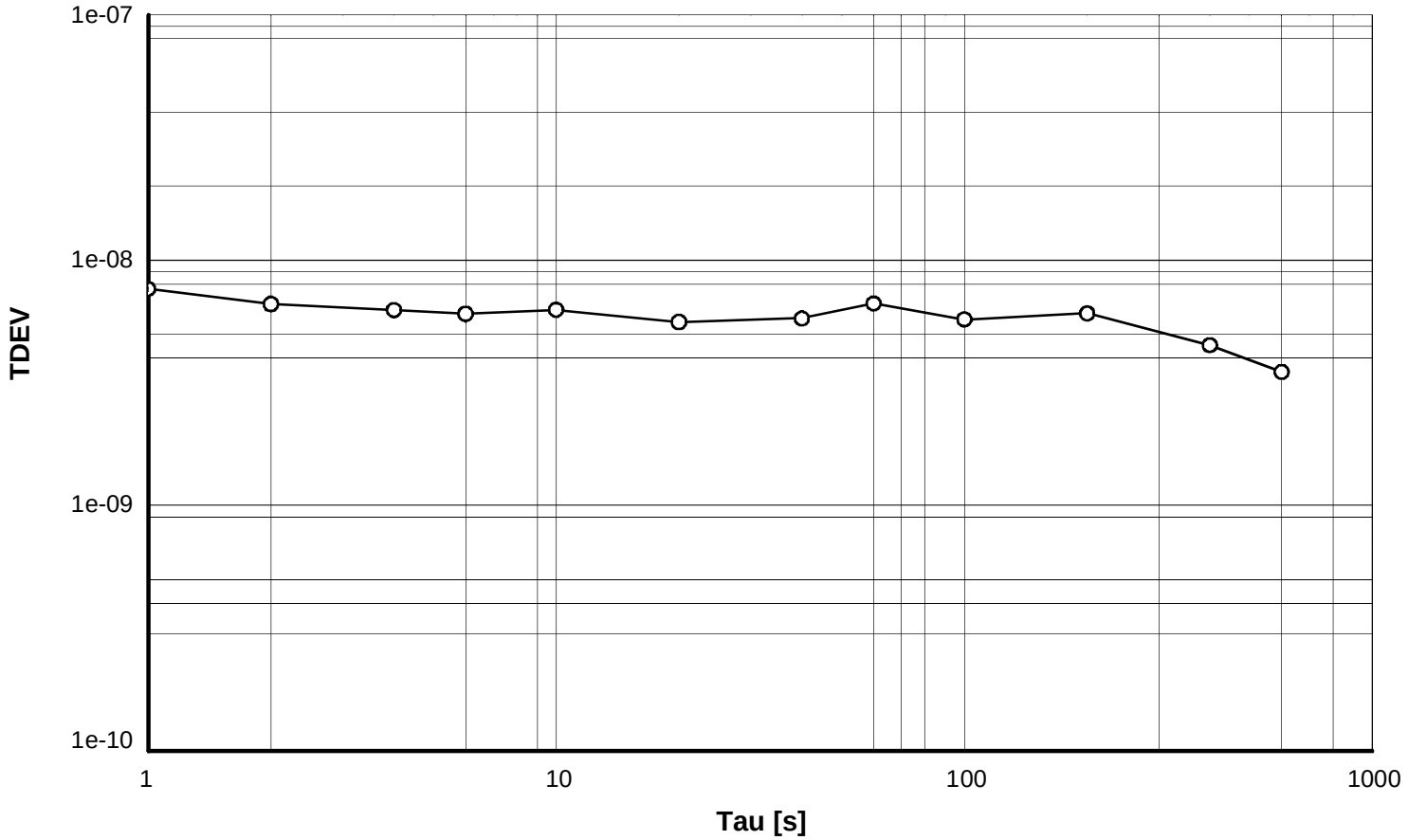


Figure 12-15 : Flicker Phase Modulation (TDEV)

12.5.15 Flicker Phase Modulation (ADEV)

Measurement: 2000 x 1 second(s)
Comments: simulated

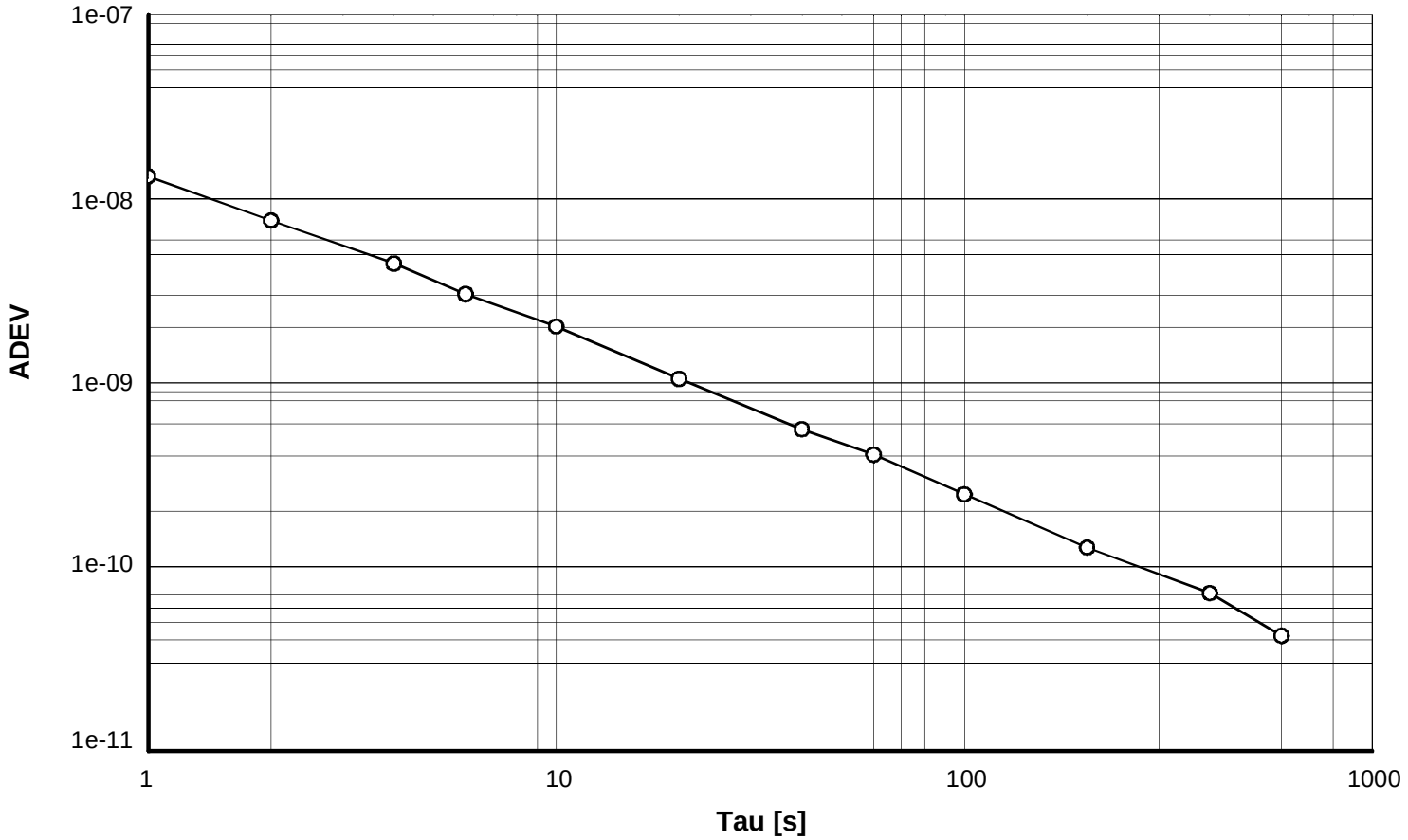


Figure 12-16 : Flicker Phase Modulation (ADEV)

12.5.16 White Frequency Modulation (TIE)

Measurement: 2000 x 1 second(s)
Comments: simulated

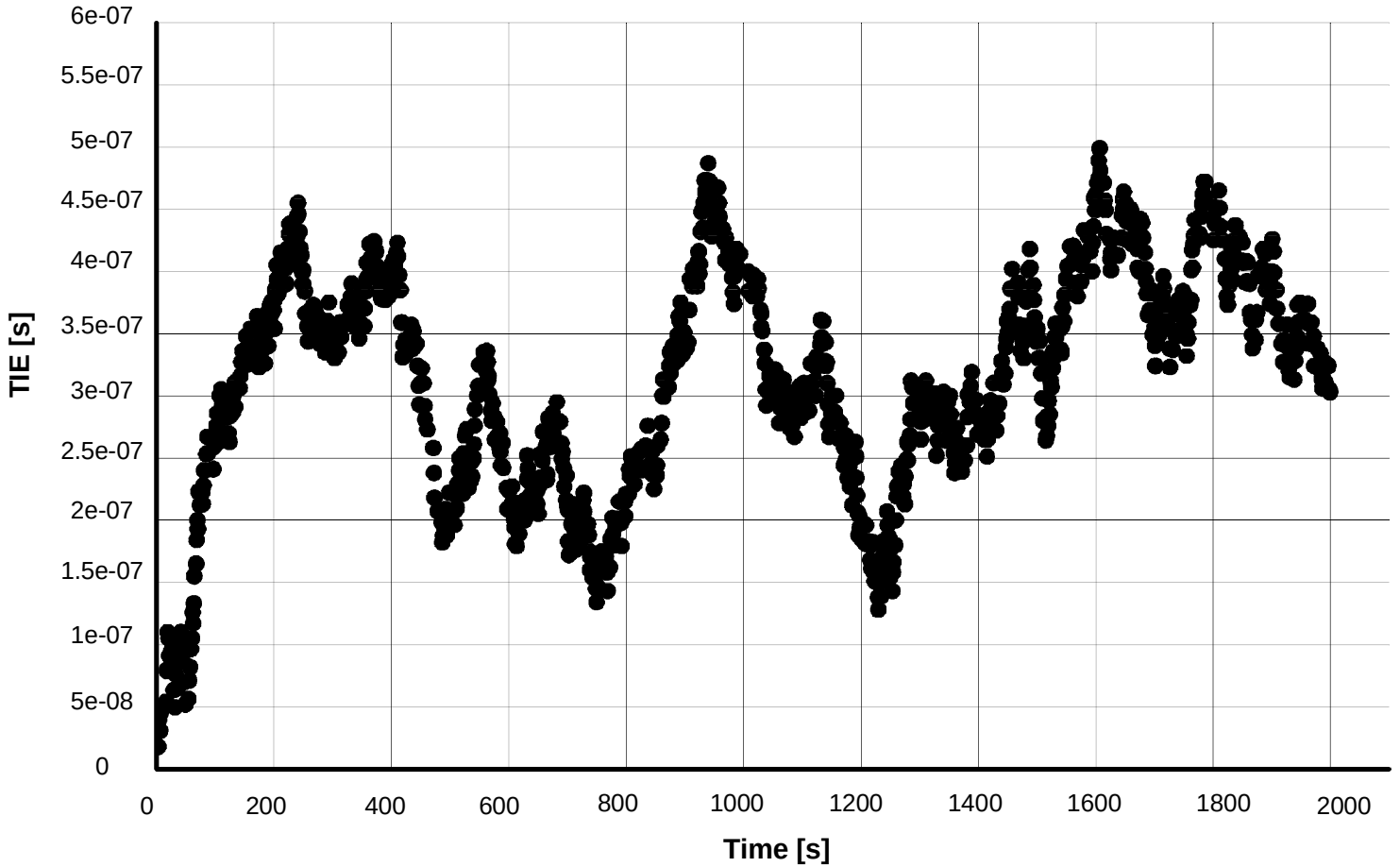


Figure 12-17 : White Frequency Modulation (TIE)

12.5.17 White Frequency Modulation (MTIE)

Measurement: 2000 x 1 second(s)
Comments: simulated

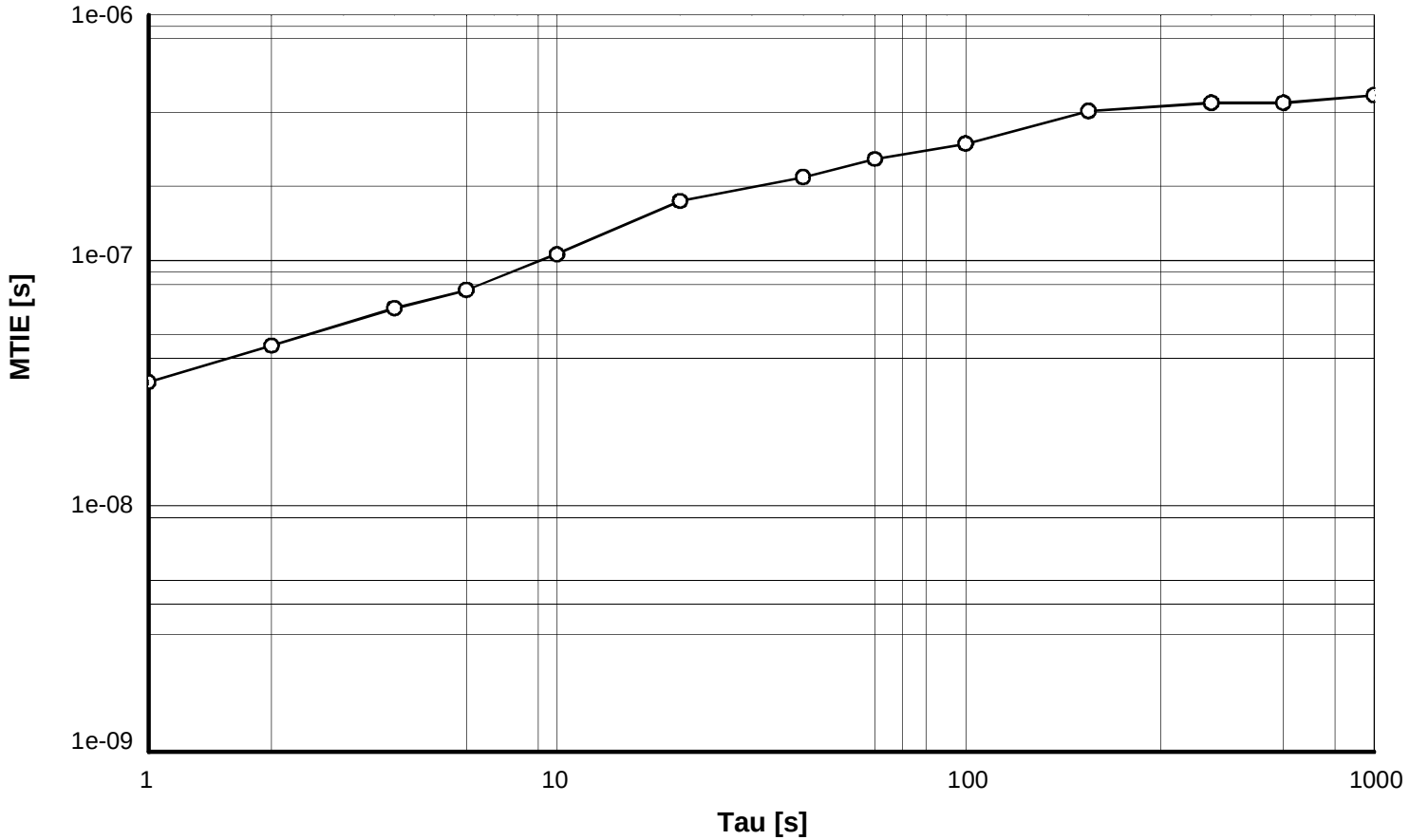


Figure 12-18 : White Frequency Modulation (MTIE)

12.5.18 White Frequency Modulation (MADEV)

Measurement: 2000 x 1 second(s)
Comments: simulated

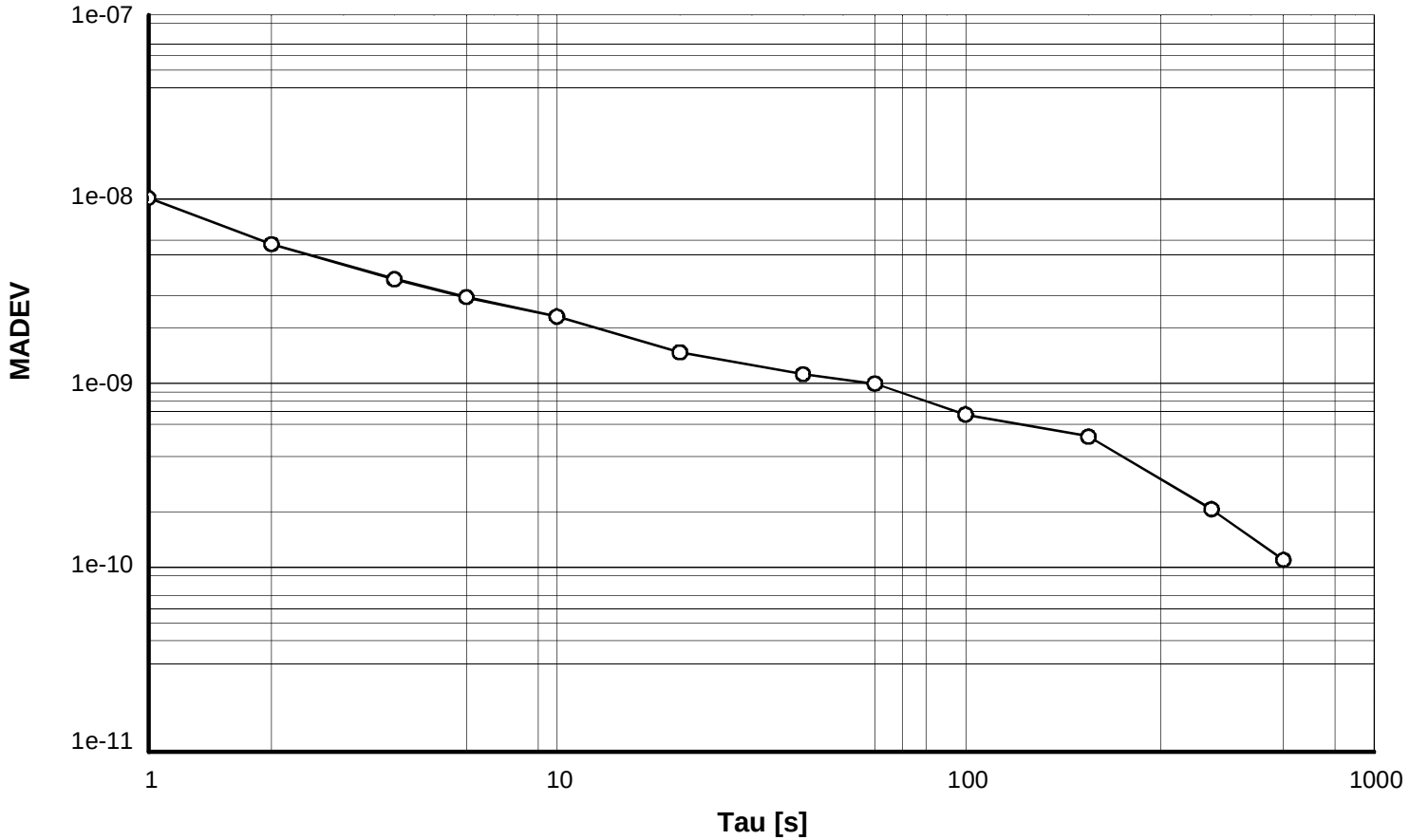


Figure 12-19 : White Frequency Modulation (MADEV)

12.5.19 White Frequency Modulation (TDEV)

Measurement: 2000 x 1 second(s)
Comments: simulated

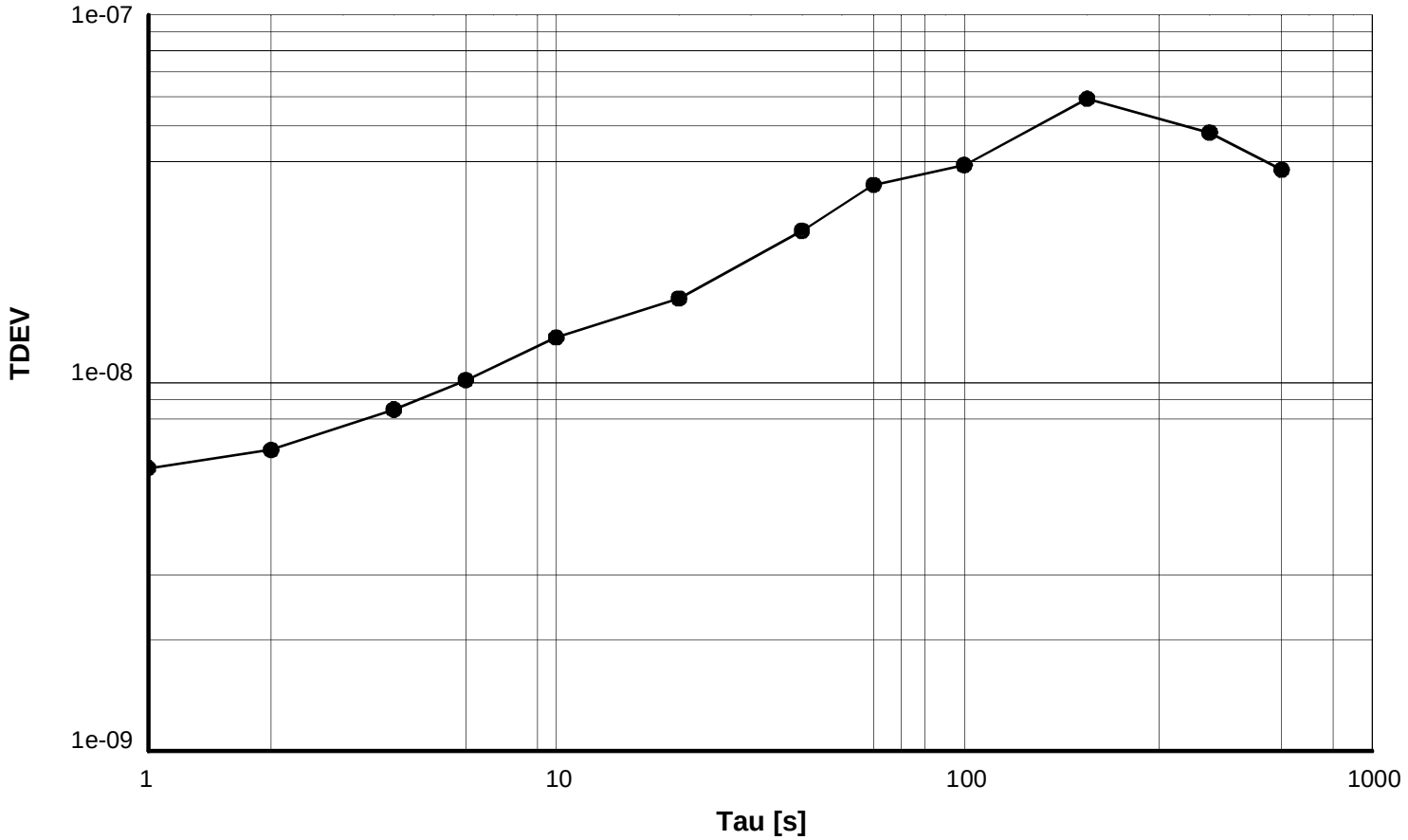


Figure 12-20 : White Frequency Modulation (TDEV)

12.5.20 White Frequency Modulation (ADEV)

Measurement: 2000 x 1 second(s)
Comments: simulated

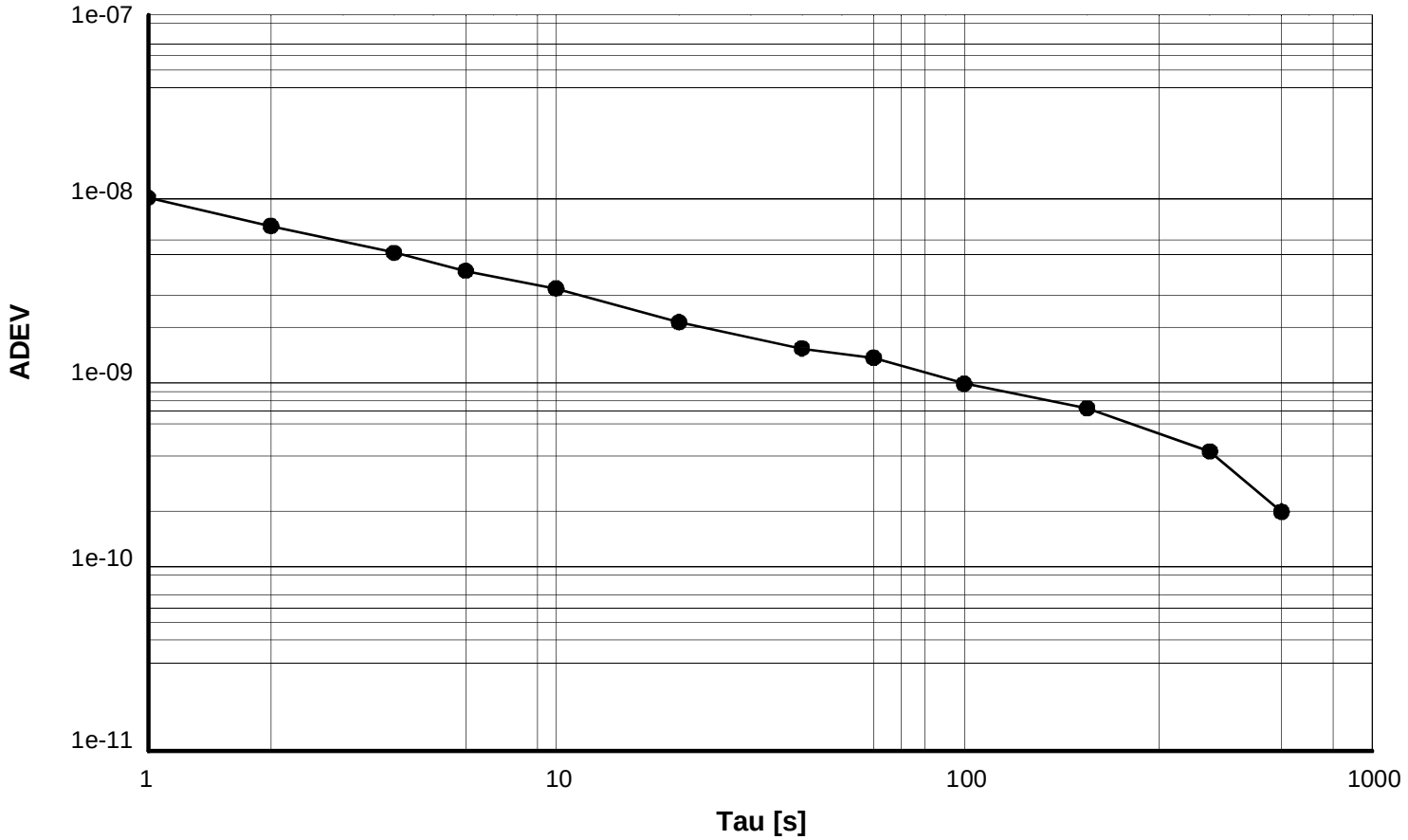


Figure 12-21 : White Frequency Modulation (ADEV)

12.5.21 Flicker Frequency Modulation (TIE)

Measurement: 2000 x 1 second(s)
Comments: simulated

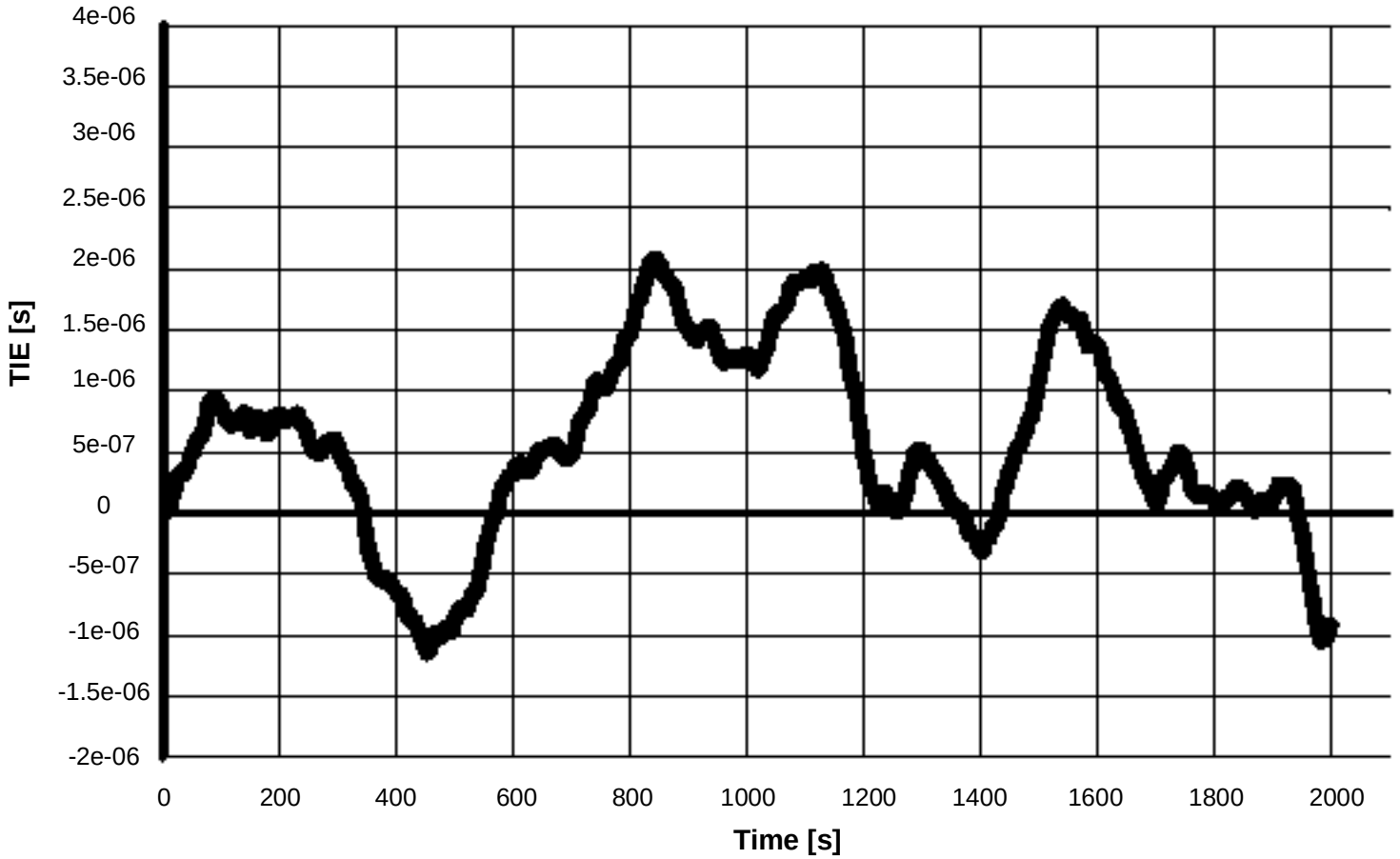


Figure 12-22 : Flicker Frequency Modulation (TIE)

12.5.22 Flicker Frequency Modulation (MTIE)

Measurement: 2000 x 1 second(s)
Comments: simulated

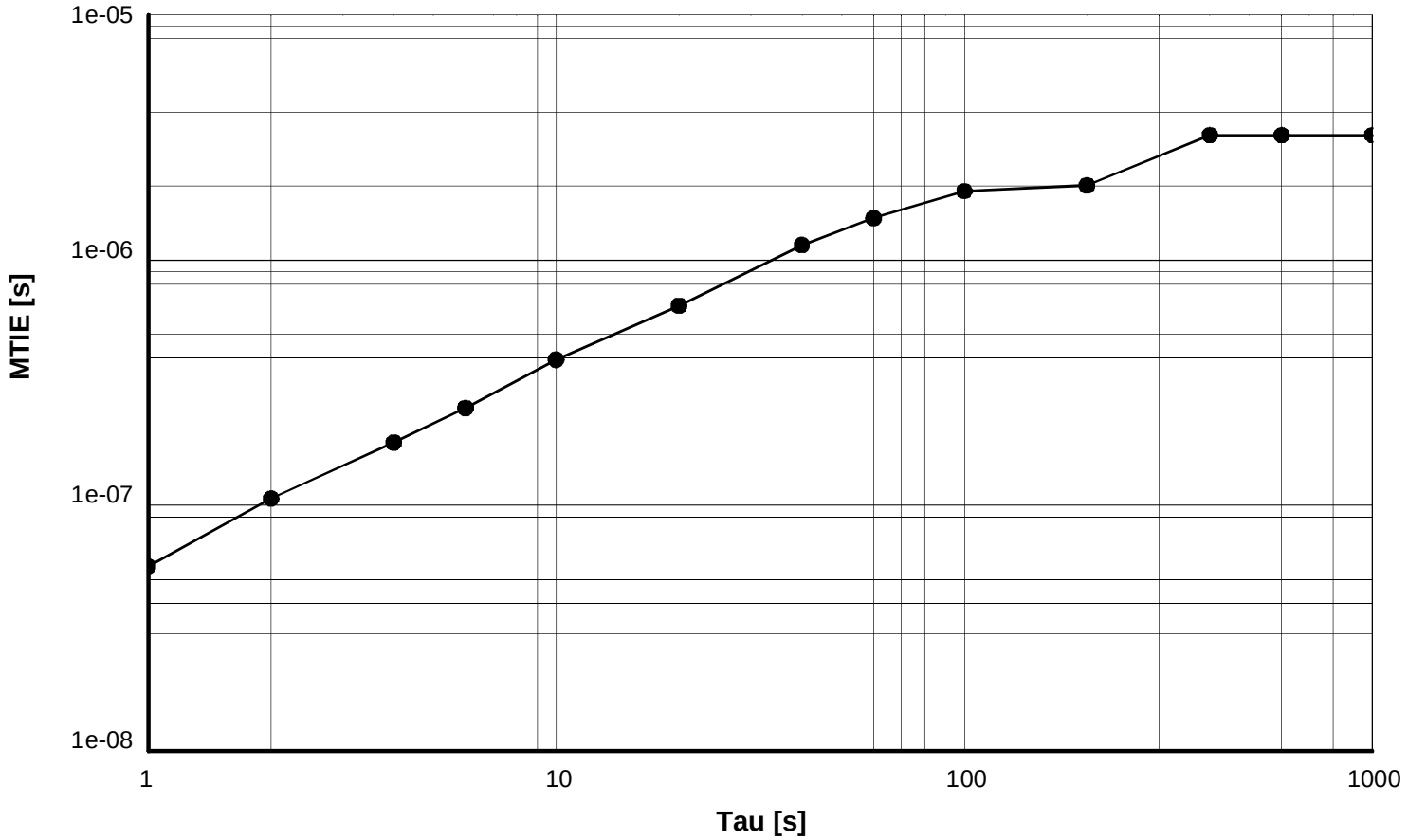


Figure 12-23 : Flicker Frequency Modulation (MTIE)

12.5.23 Flicker Frequency Modulation (MADEV)

Measurement: 2000 x 1 second(s)
Comments: simulated

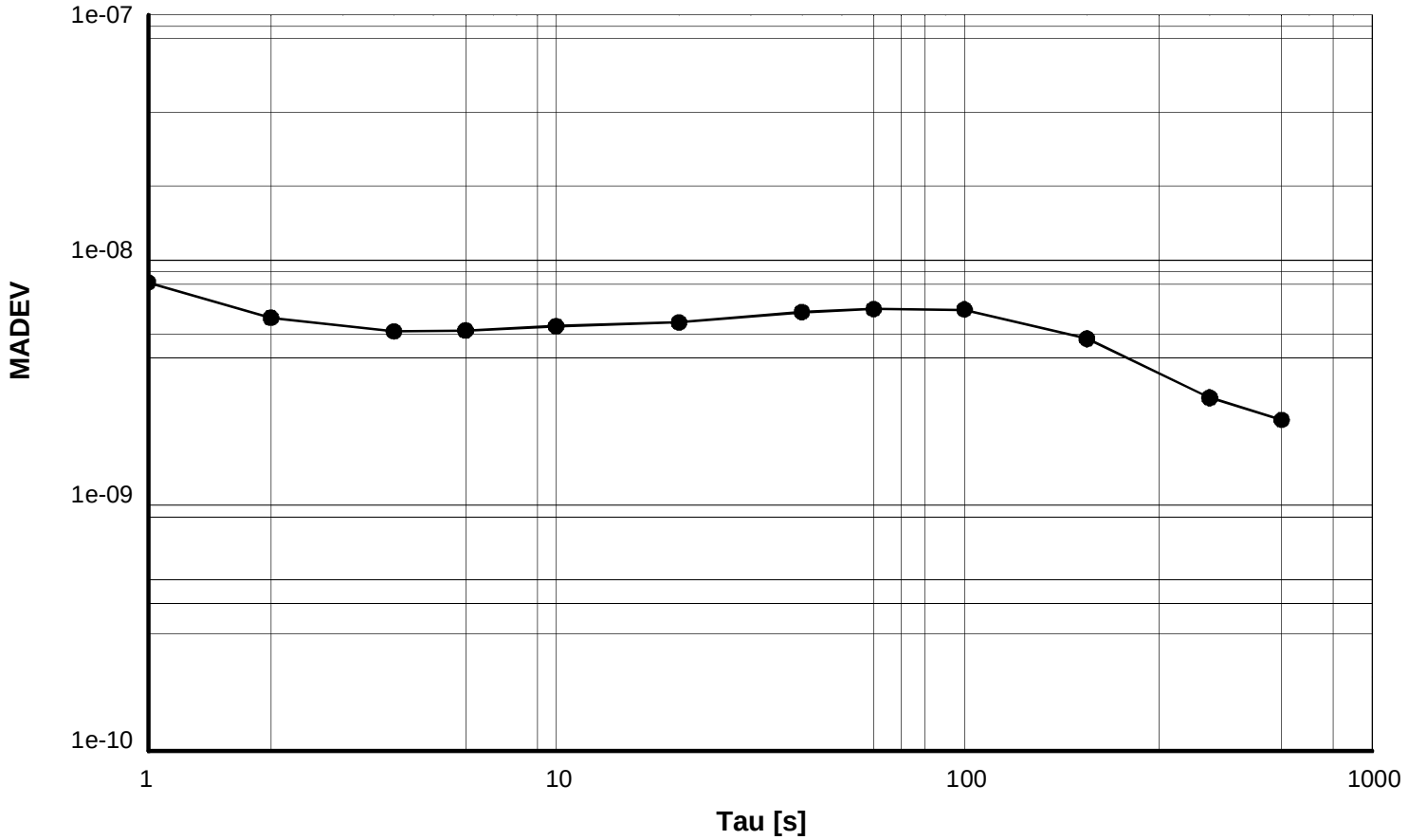


Figure 12-24 : Flicker Frequency Modulation (MADEV)

12.5.24 Flicker Frequency Modulation (TDEV)

Measurement: 2000 x 1 second(s)
Comments: simulated

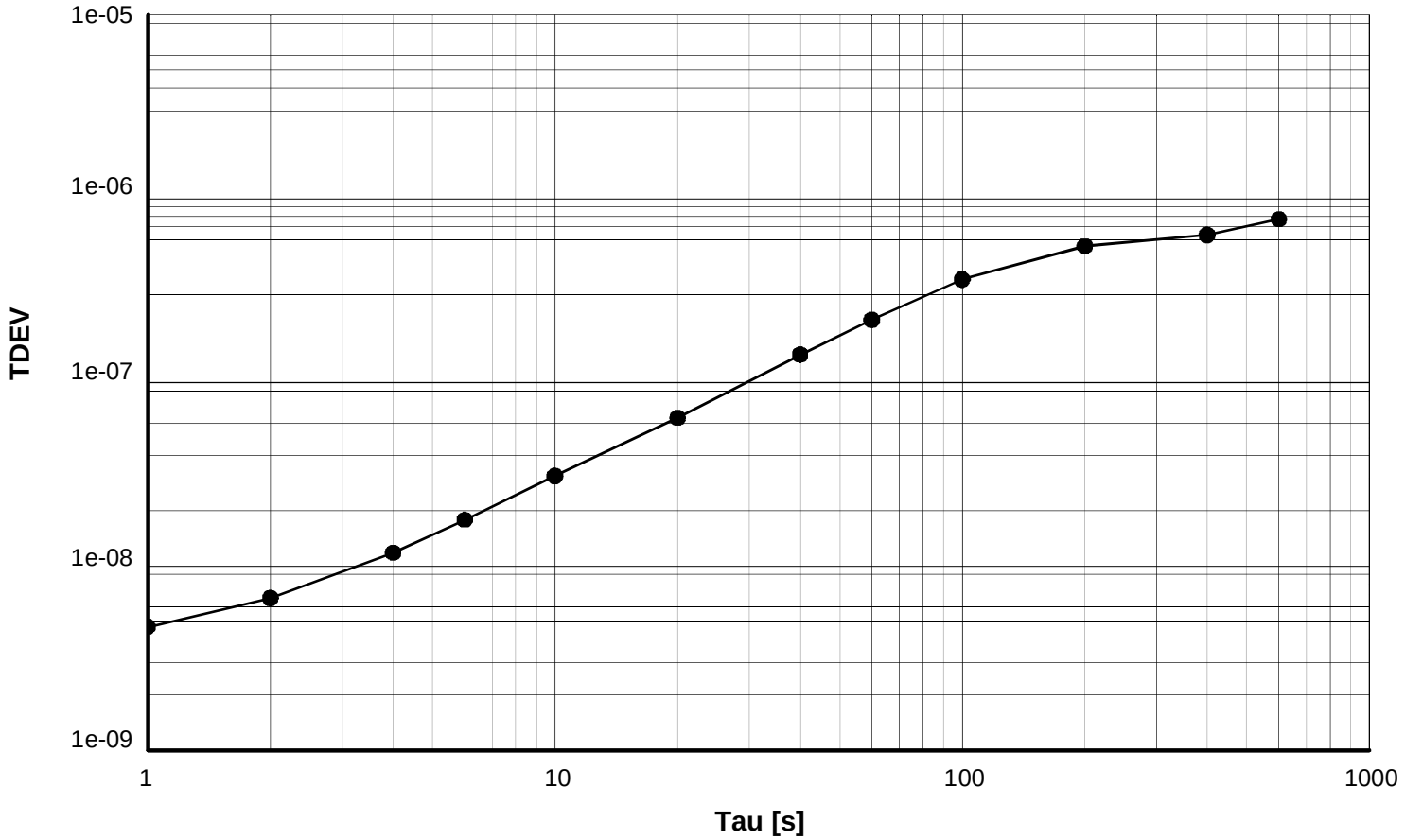


Figure 12-25 : Flicker Frequency Modulation (TIE)

12.5.25 Flicker Frequency Modulation (ADEV)

Measurement: 2000 x 1 second(s)
Comments: simulated

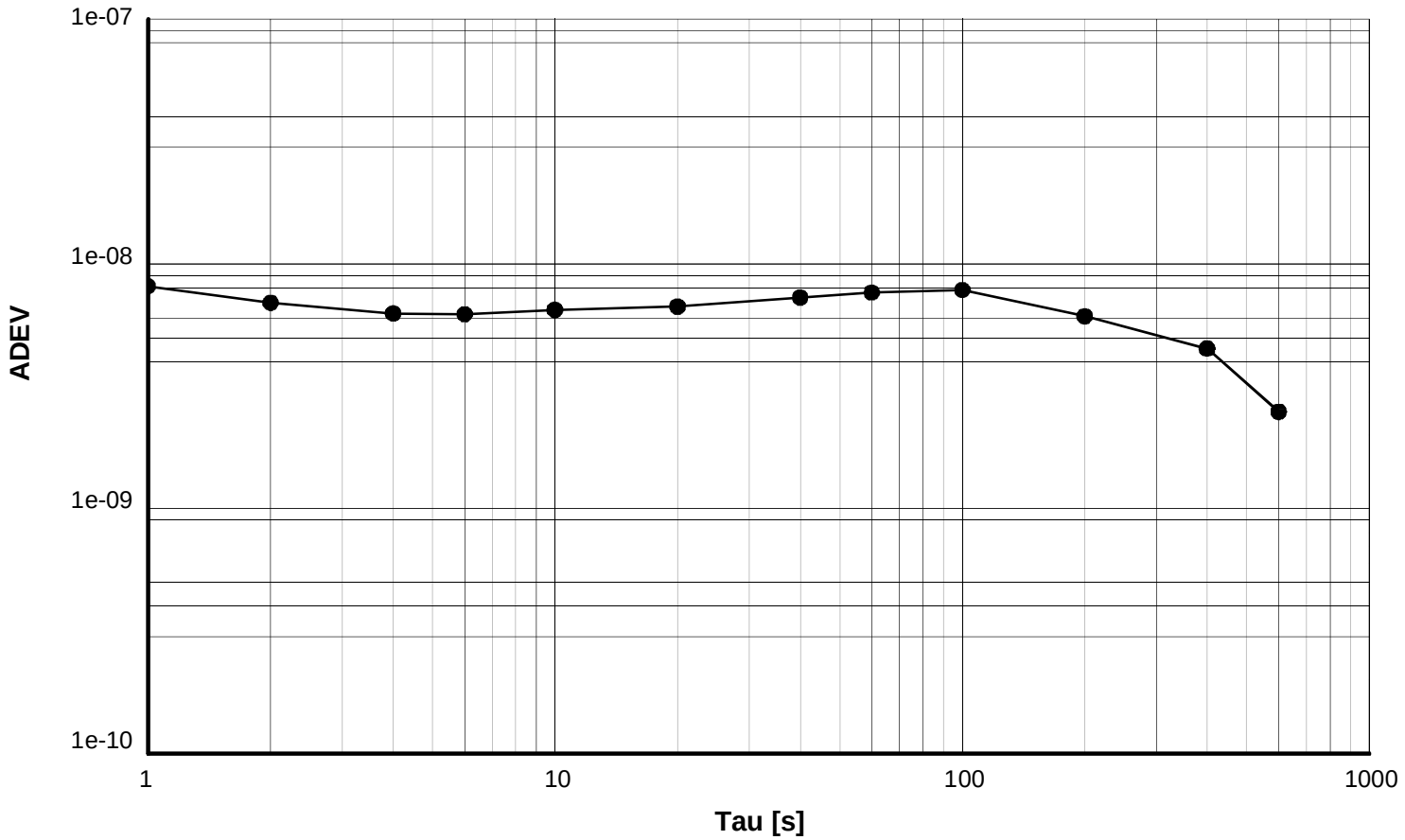


Figure 12-26 : Flicker Frequency Modulation (ADEV)

12.5.26 Random Walk Frequency Modulation (TIE)

Measurement: 2000 x 1 second(s)
Comments: simulated

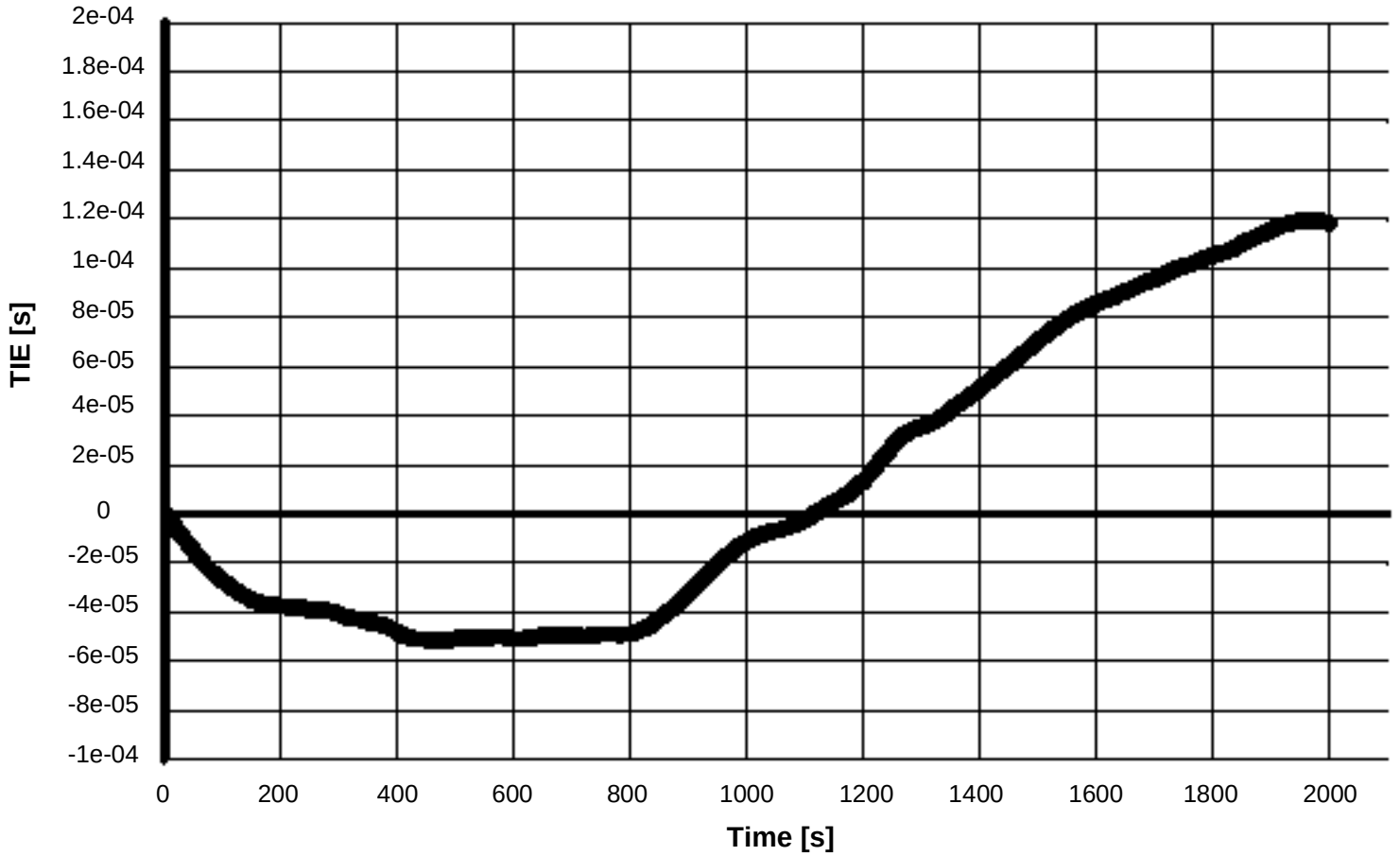


Figure 12-27 : Random Walk Frequency Modulation (TIE)

12.5.27 Random Walk Frequency Modulation (MTIE)

Measurement: 2000 x 1 second(s)
Comments: simulated

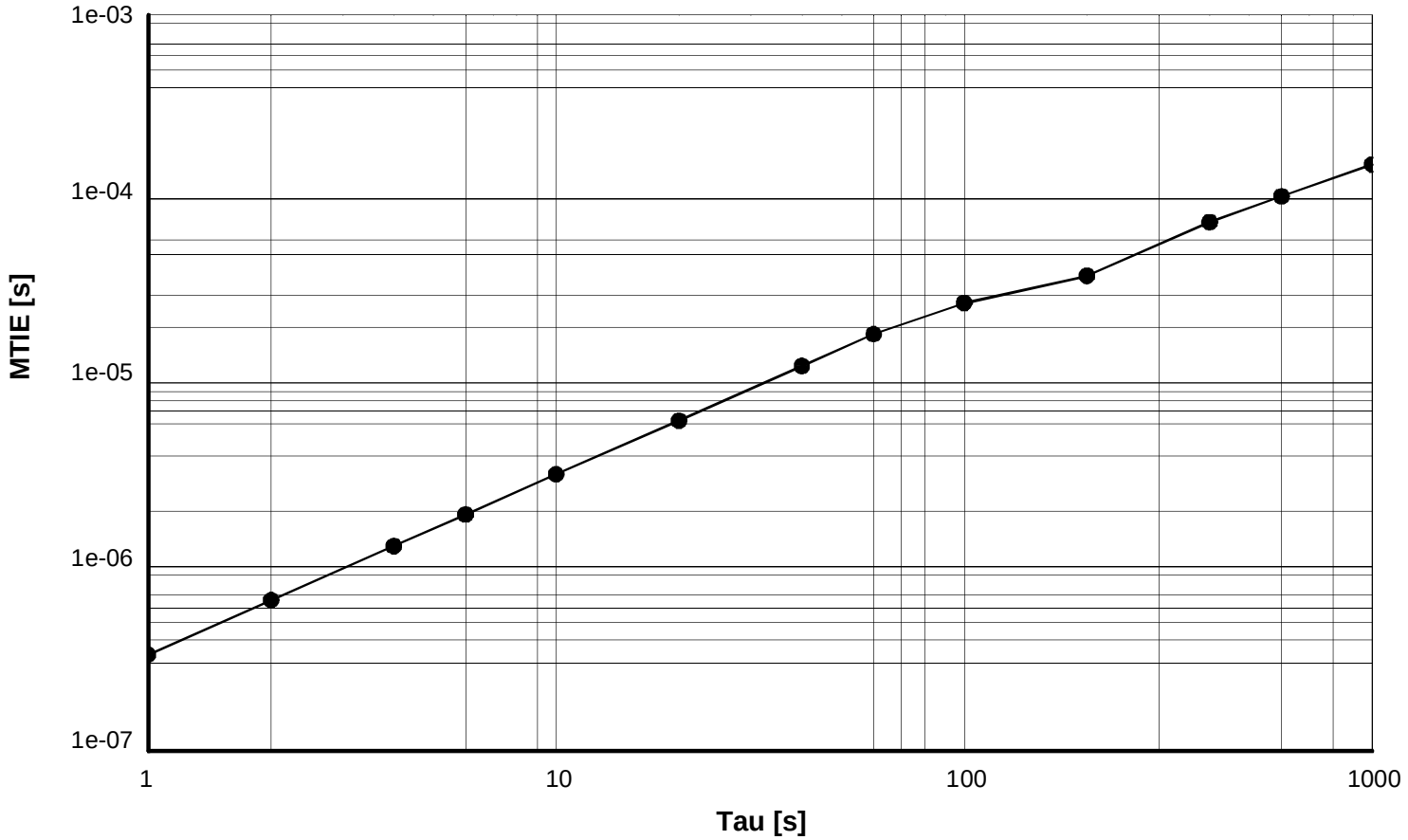


Figure 12-28 : Random Walk Frequency Modulation (MTIE)

12.5.28 Random Walk Frequency Modulation (MADEV)

Measurement: 2000 x 1 second(s)
Comments: simulated

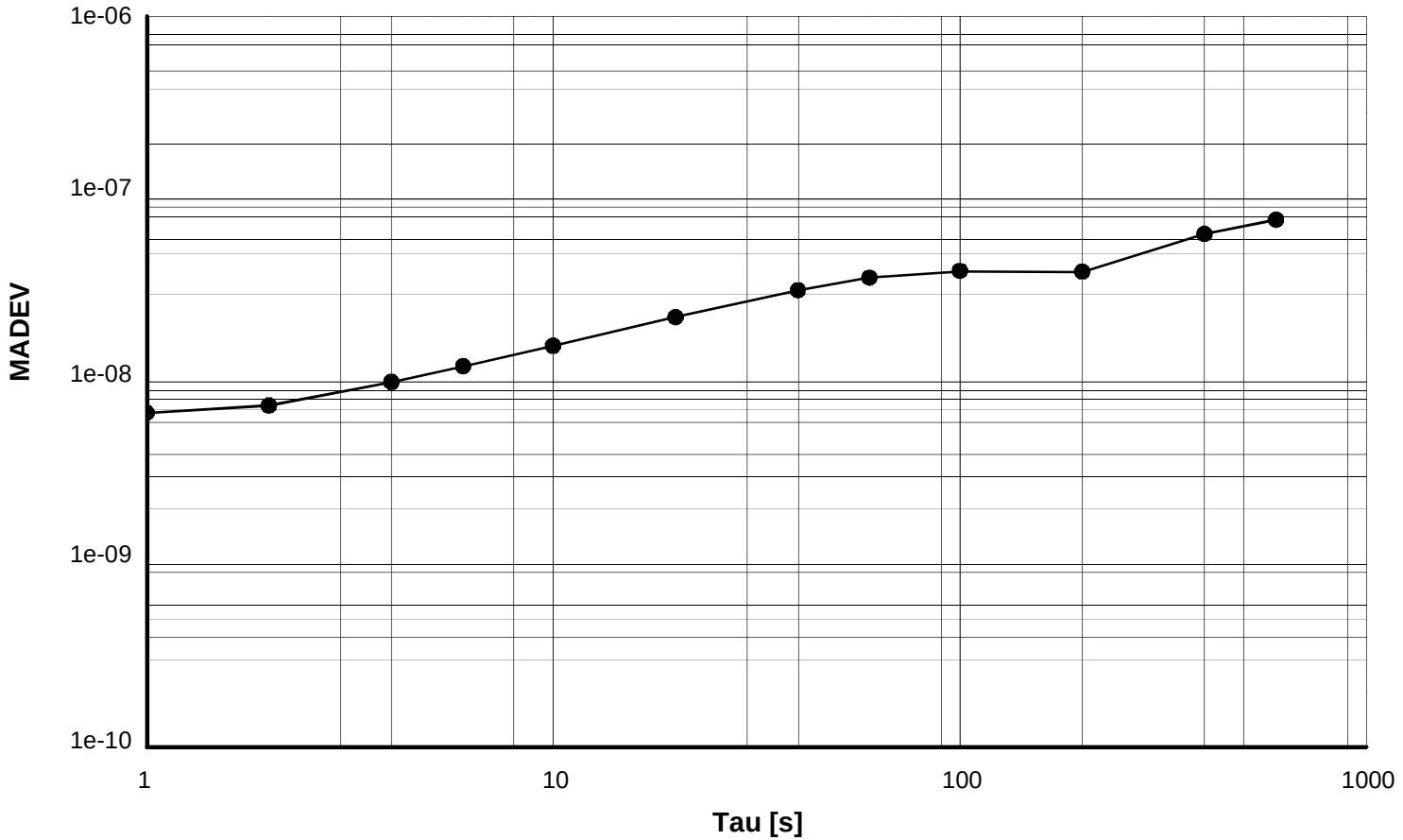


Figure 12-29 : Random Walk Frequency Modulation (MADEV)

12.5.29 Random Walk Frequency Modulation (TDEV)

Measurement: 2000 x 1 second(s)
Comments: simulated

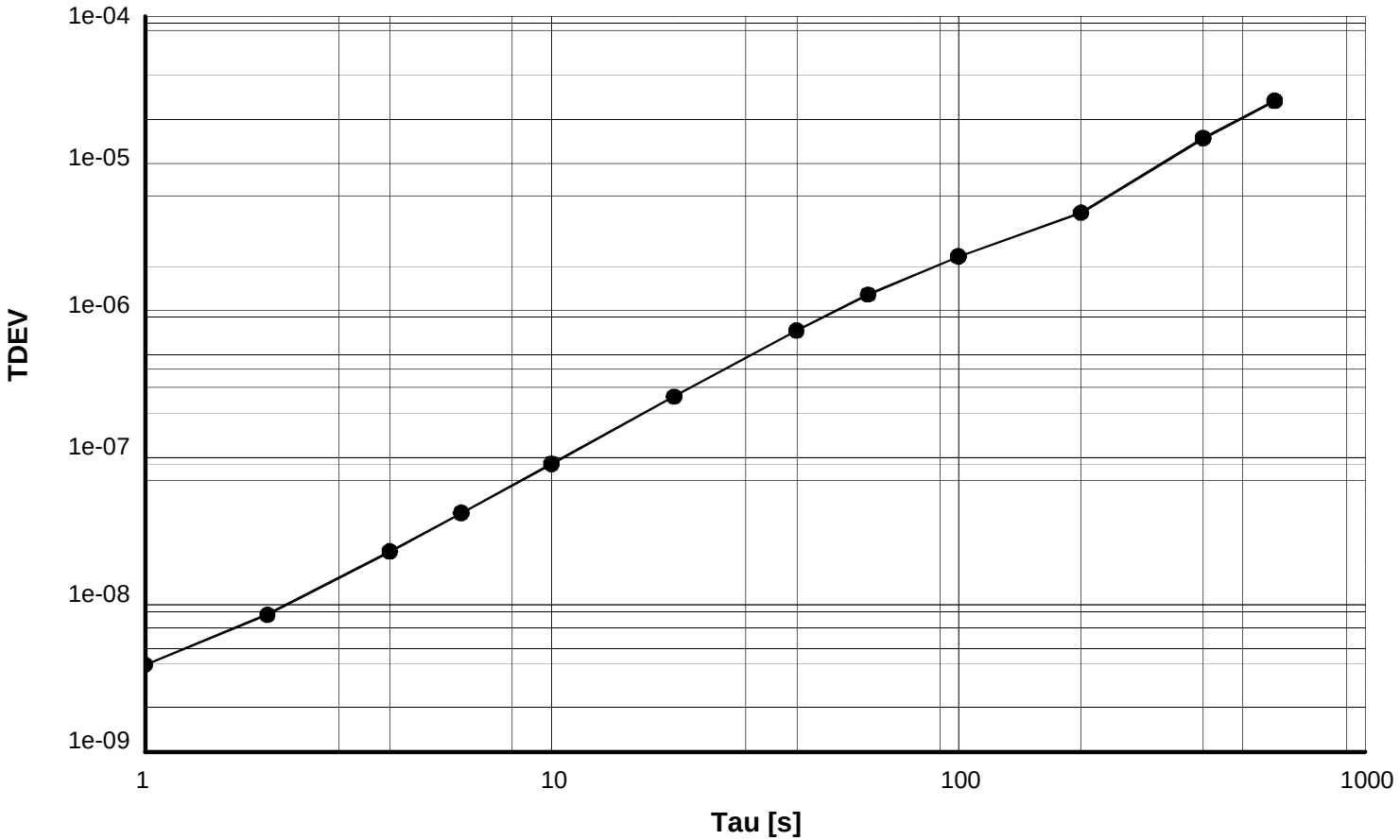


Figure 12-30 : Random Walk Frequency Modulation (TDEV)

12.5.30 Random Walk Frequency Modulation (ADEV)

Measurement: 2000 x 1 second(s)
Comments: simulated

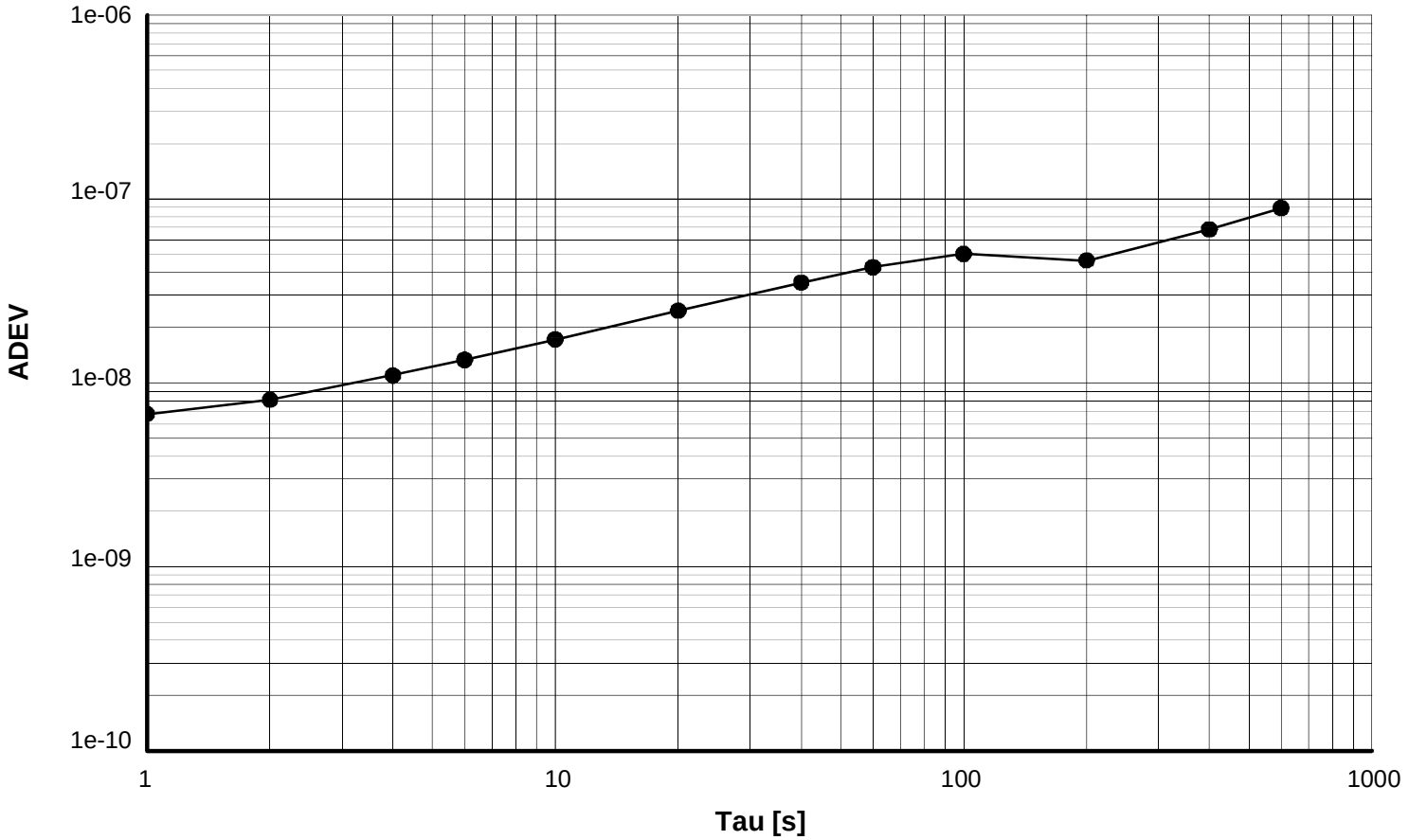


Figure 12-31 : Random Walk Frequency Modulation (ADEV)

12.5.31 White Phase Modulation + Jump 100 ns (TIE)

Measurement: 2000 x 1 second(s)
Comments: simulated

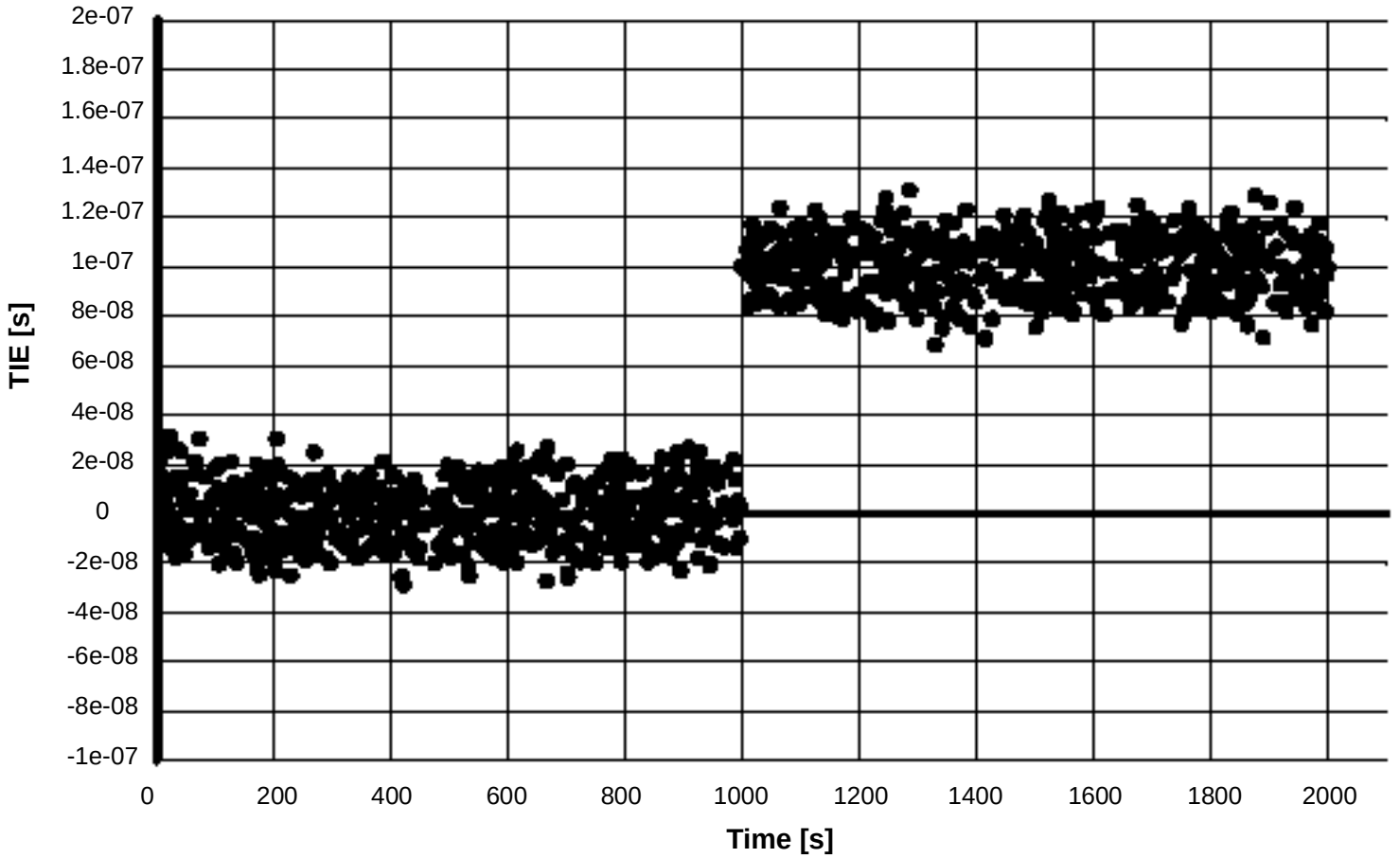


Figure 12-32 : White Phase Modulation + Jump 100 ns (TIE)

12.5.32 White Phase Modulation + Jump 100 ns (MTIE)

Measurement: 2000 x 1 second(s)
Comments: simulated

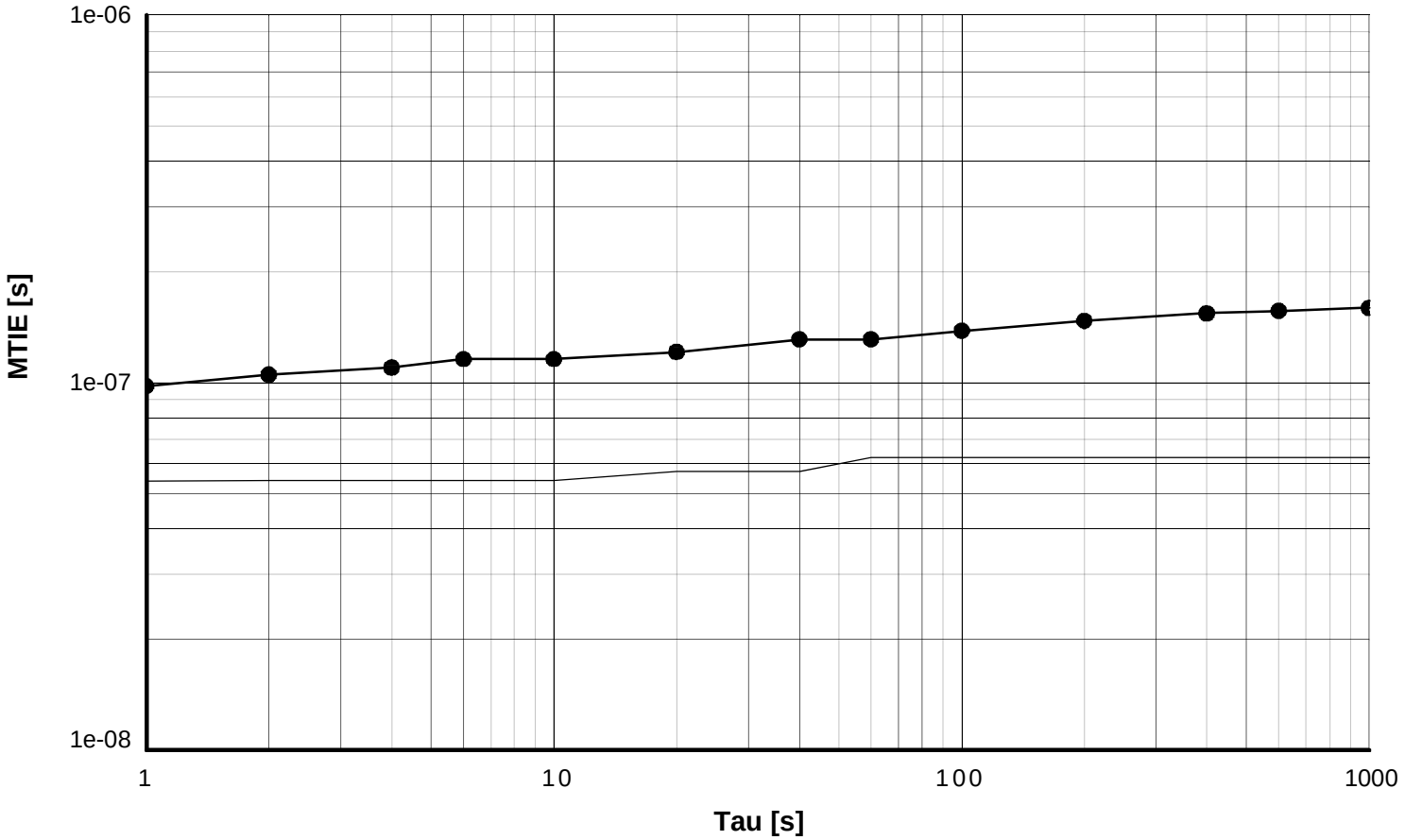


Figure 12-33 : White Phase Modulation + Jump 100 ns (MTIE)

12.5.33 White Phase Modulation + Jump 100 ns (MADEV)

Measurement: 2000 x 1 second(s)
Comments: simulated

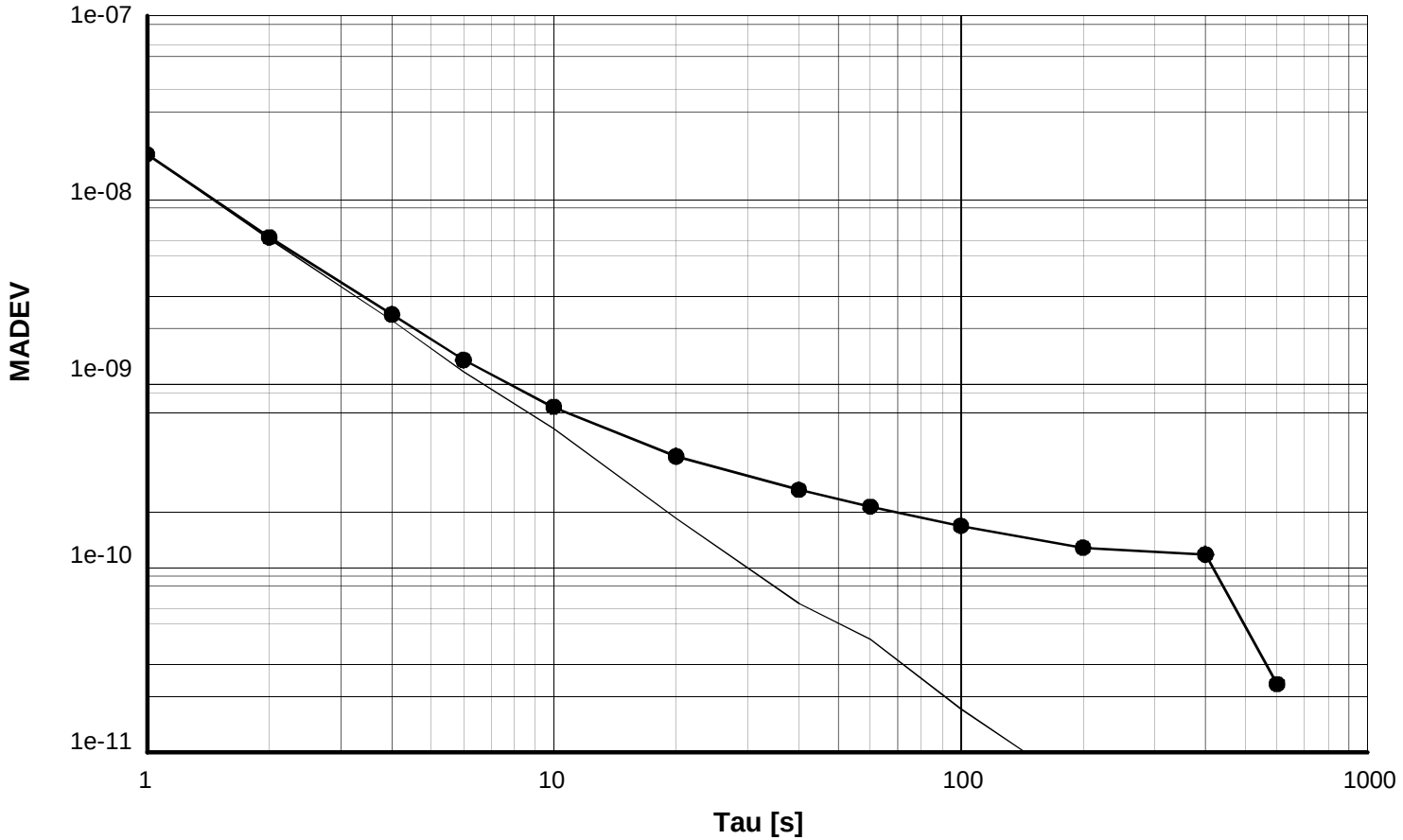


Figure 12-34 : White Phase Modulation + Jump 100 ns (MADEV)

12.5.34 White Phase Modulation + Jump 100 ns (TDEV)

Measurement: 2000 x 1 second(s)
Comments: simulated

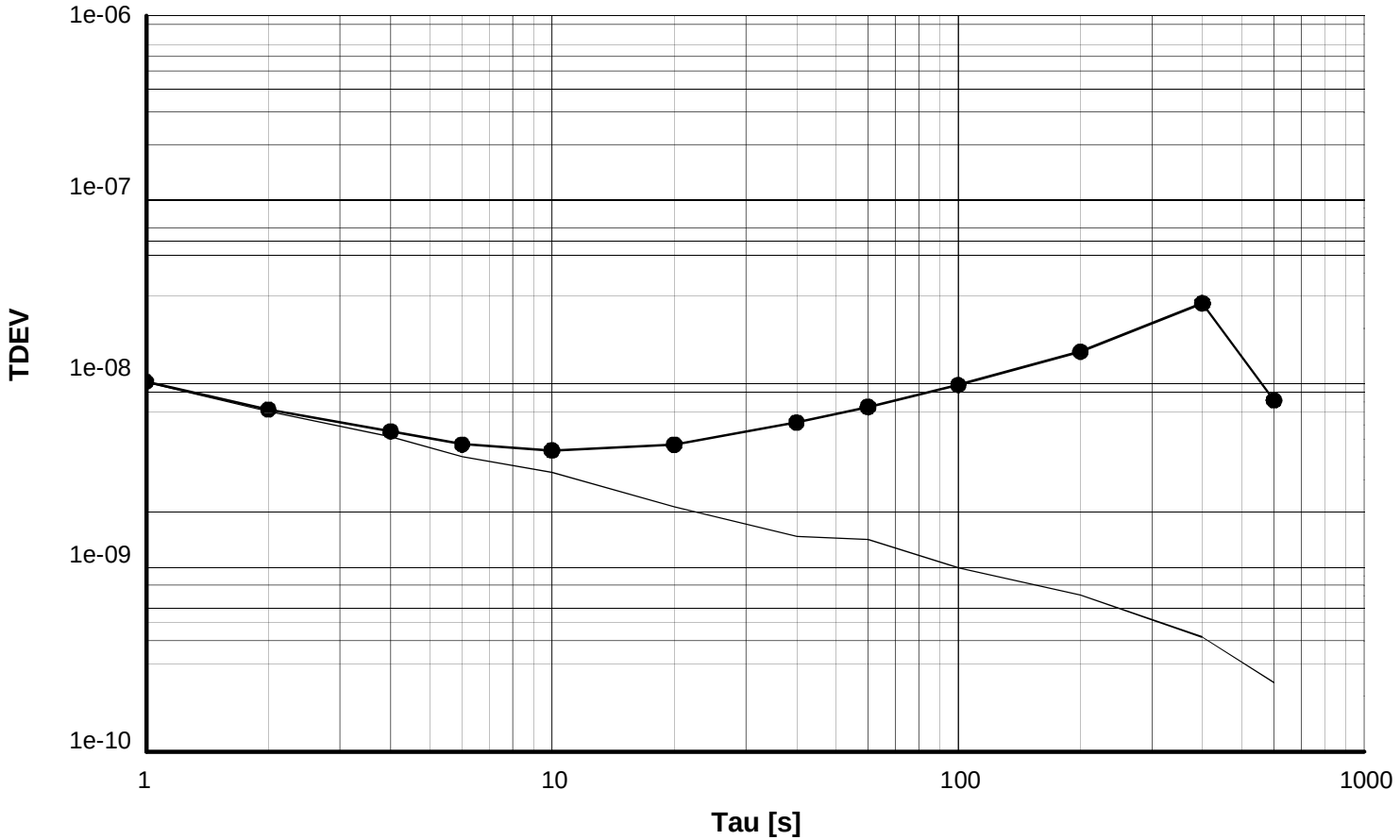


Figure 12-35 : White Phase Modulation + Jump 100 ns (TDEV)

12.5.35 White Phase Modulation + Jump 100 ns (ADEV)

Measurement: 2000 x 1 second(s)
Comments: simulated

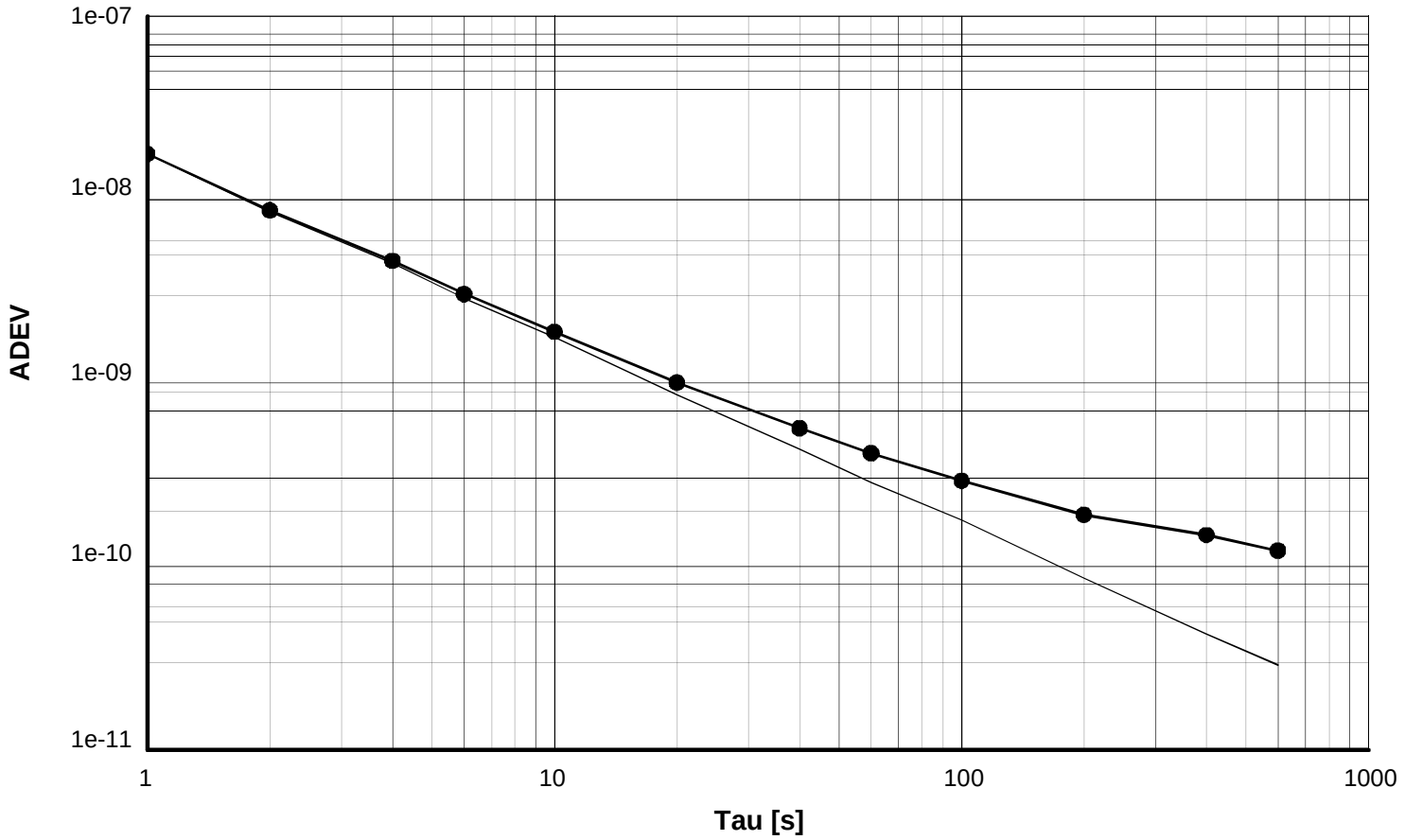


Figure 12-36 : White Phase Modulation + Jump 100 ns (ADEV)

12.5.36 White Phase Modulation + Frequency Offset 1e-9 (TIE)

Measurement: 2000 x 1 second(s)
Comments: simulated

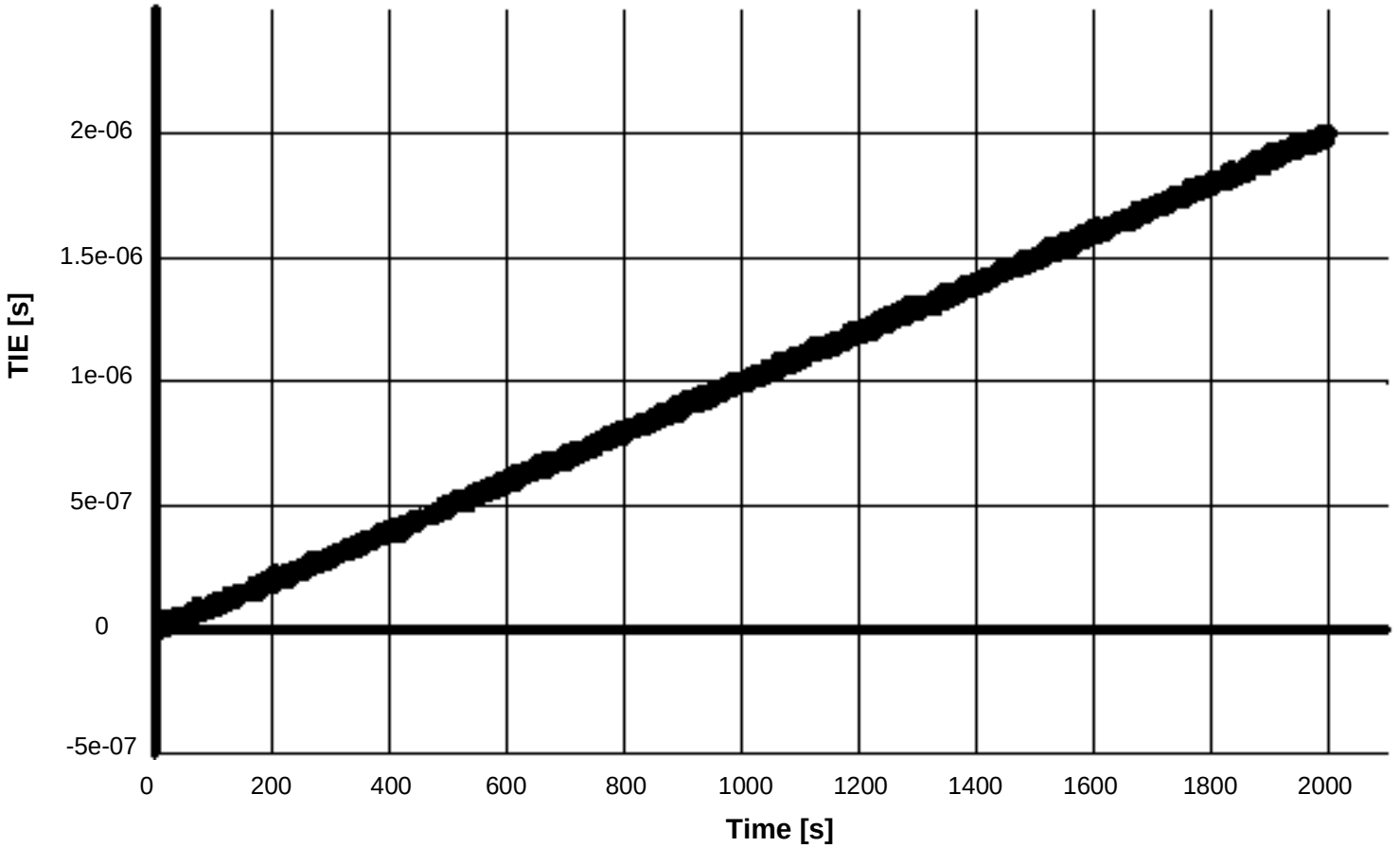


Figure 12-37 : White Phase Modulation + Frequency Offset 1e-9 (TIE)

12.5.37 White Phase Modulation + Frequency Offset 1e-9 (MTIE)

Measurement: 2000 x 1 second(s)
Comments: simulated

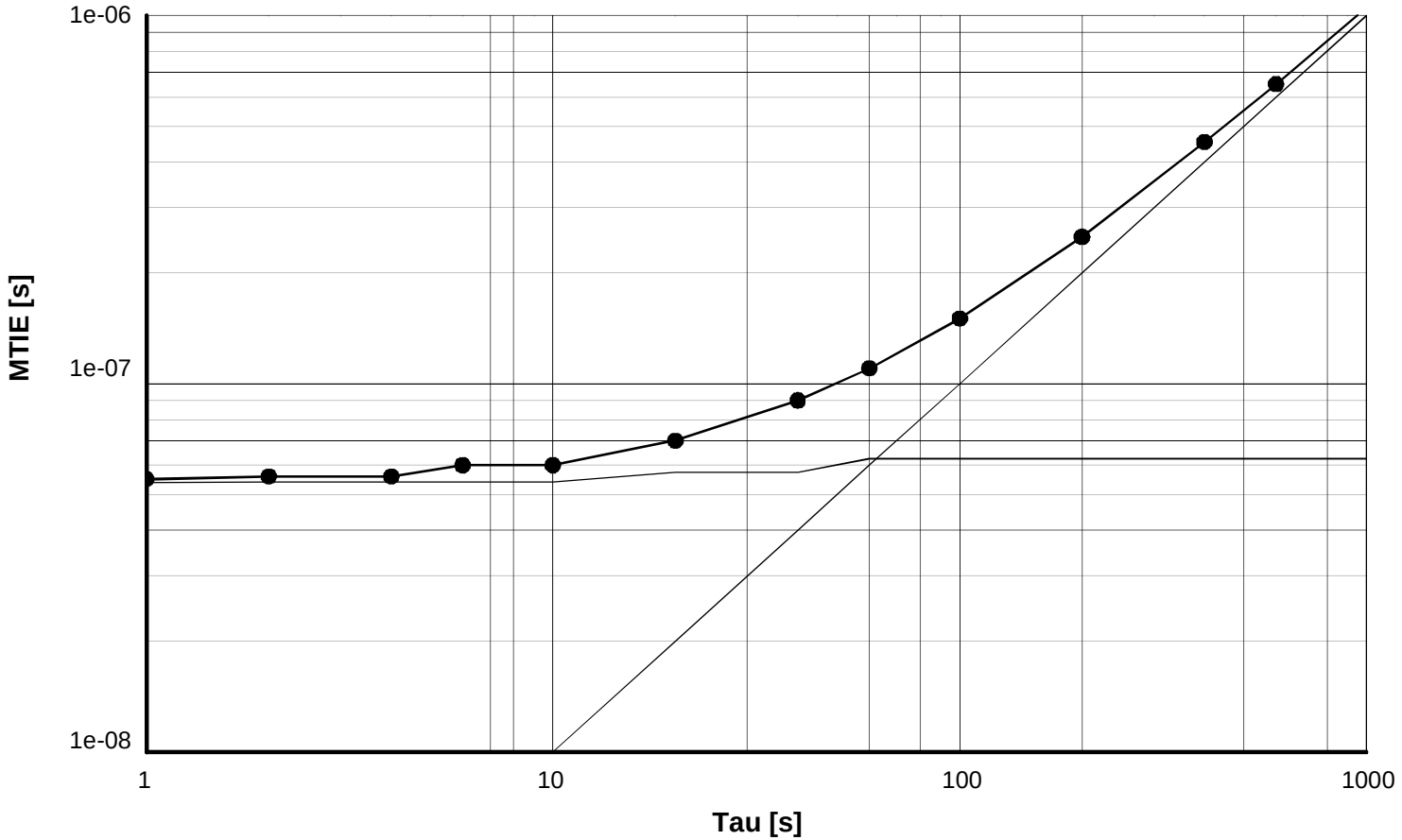


Figure 12-38 : White Phase Modulation + Frequency Offset 1e-9 (MTIE)

12.5.38 White Phase Modulation + Frequency Drift 8.64e-8/day (TIE)

Measurement: 2000 x 1 second(s)
Comments: simulated

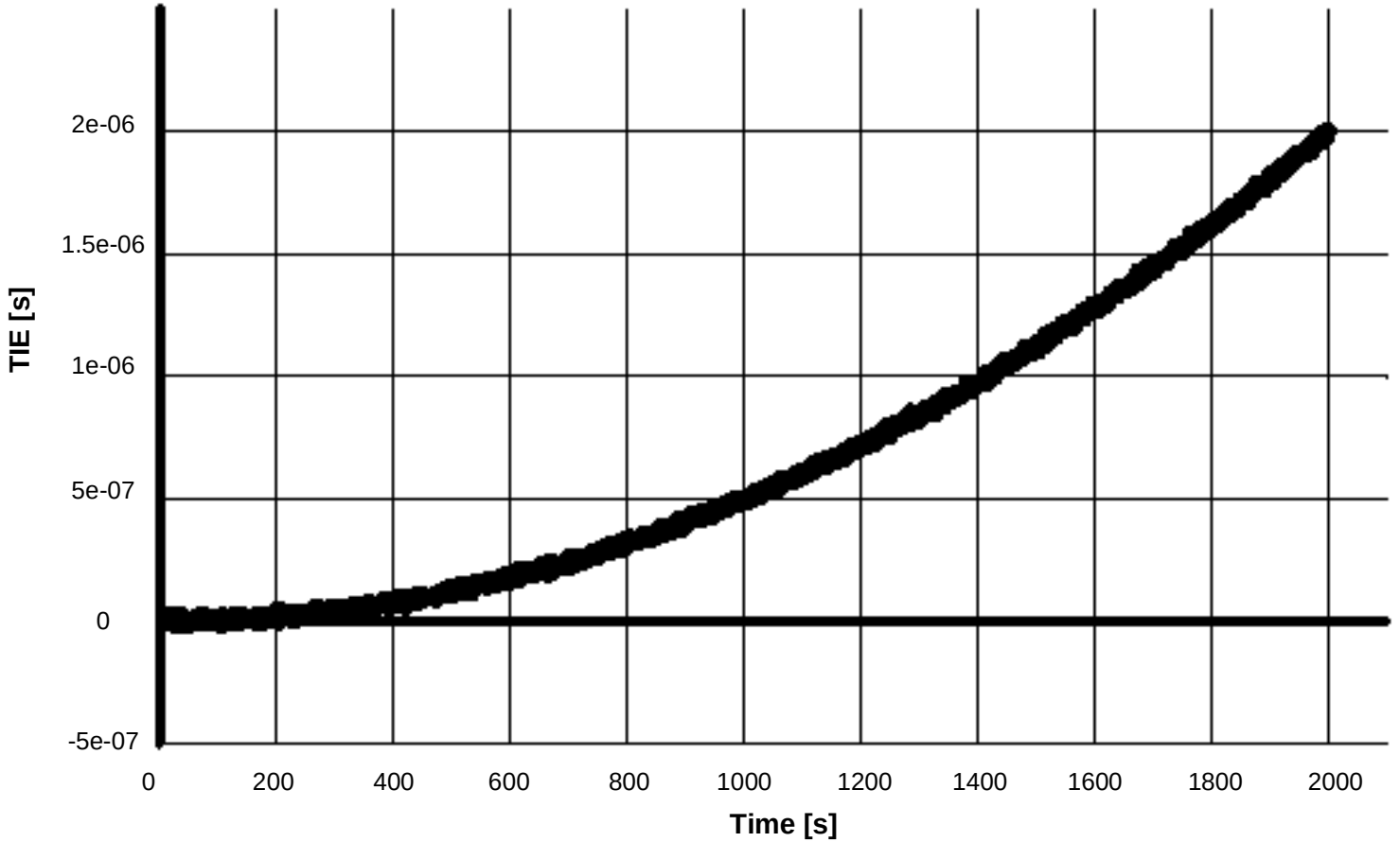


Figure 12-39 : White Phase Modulation + Frequency Drift 8.64e-8/day (TIE)

12.5.39 White Phase Modulation + Frequency Drift 8.64e-8/day (MTIE)

Measurement: 2000 x 1 second(s)
Comments: simulated

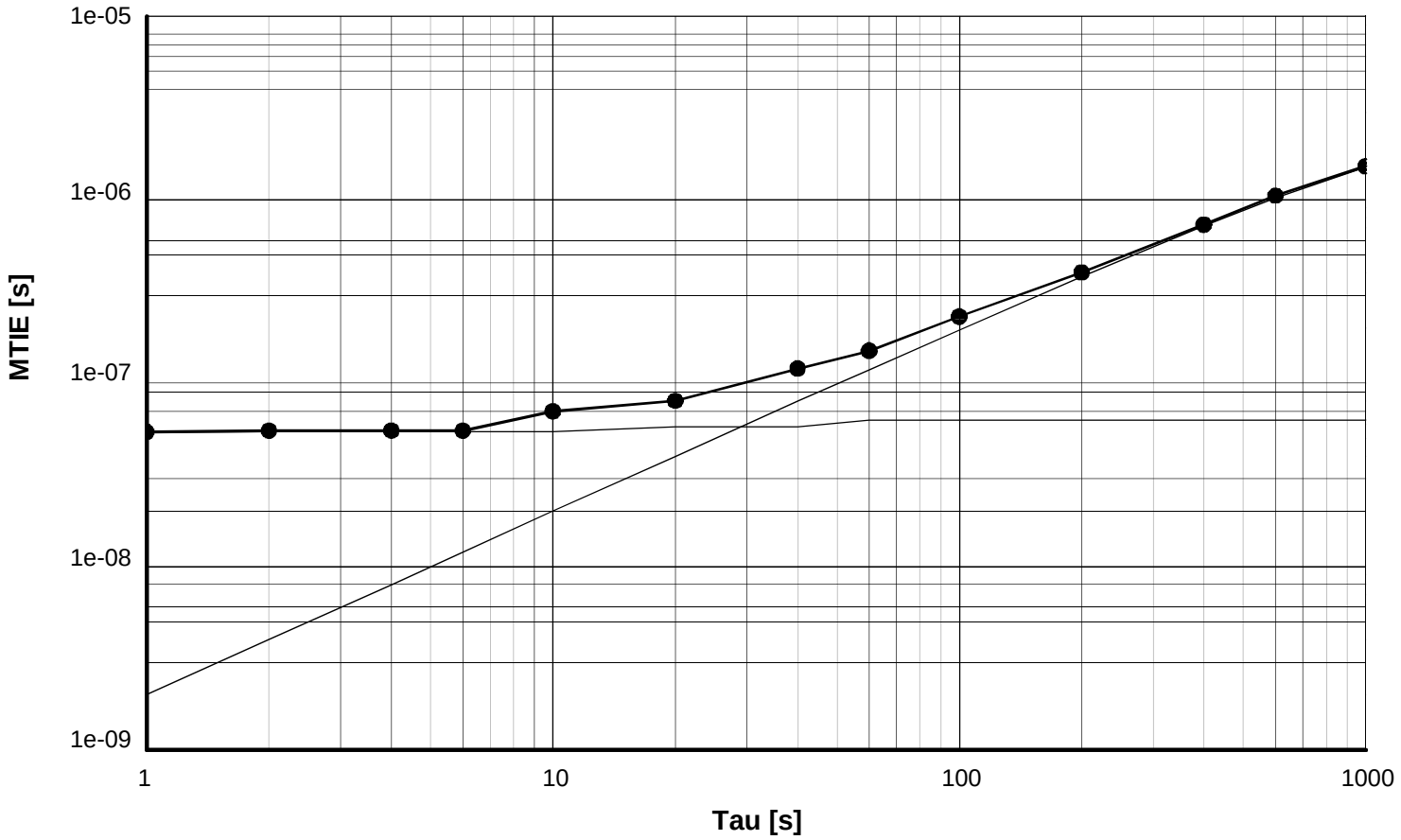


Figure 12-40 : White Phase Modulation + Frequency Drift 8.64e-8/day (MTIE)

12.5.40 White Phase Modulation + Frequency Drift 8.64e-8/day (MADEV)

Measurement: 2000 x 1 second(s)
Comments: simulated

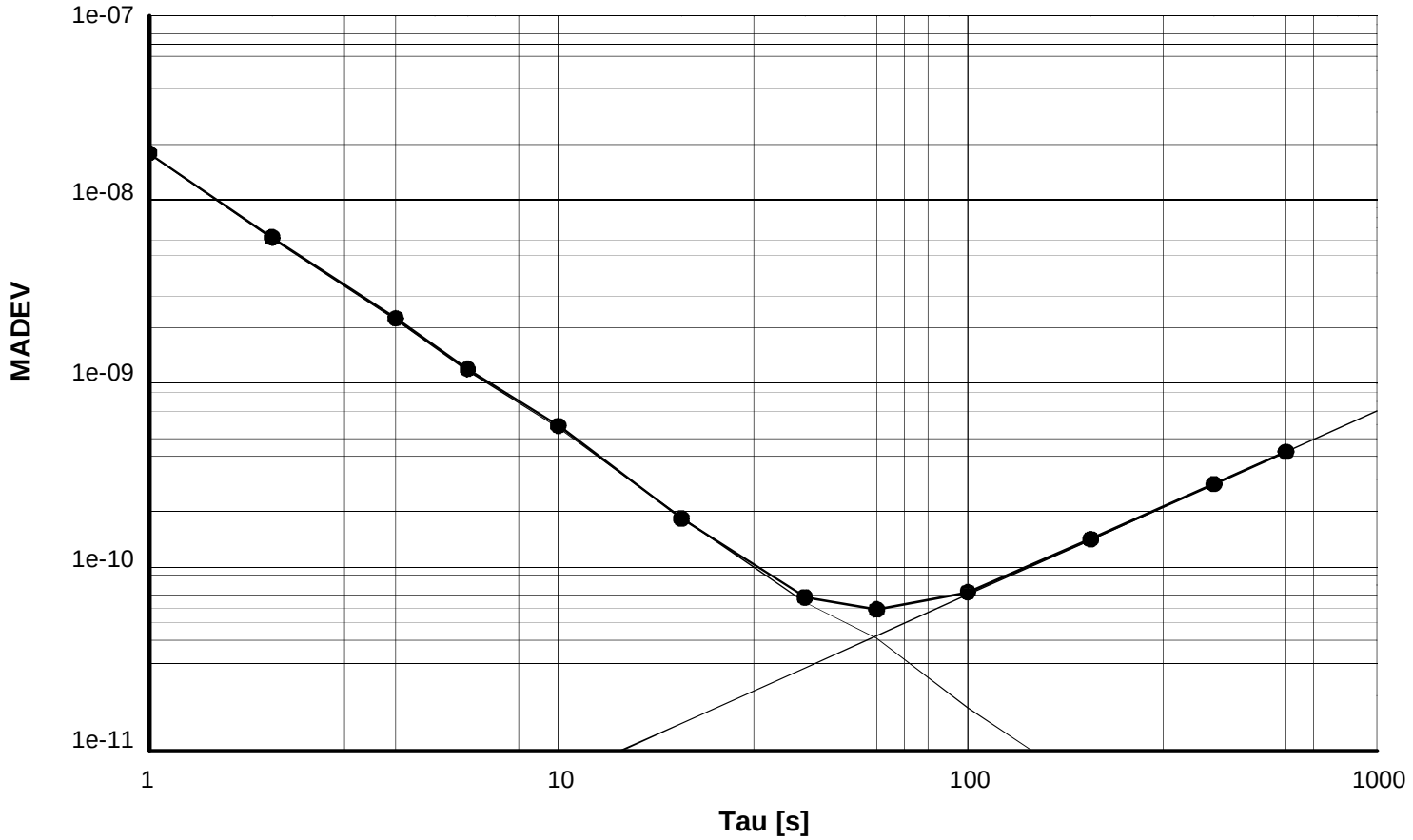


Figure 12-41 : White Phase Modulation + Frequency Drift 8.64e-8/day (MADEV)

12.5.41 White Phase Modulation + Frequency Drift 8.64e-8/day (TDEV)

Measurement: 2000 x 1 second(s)
Comments: simulated

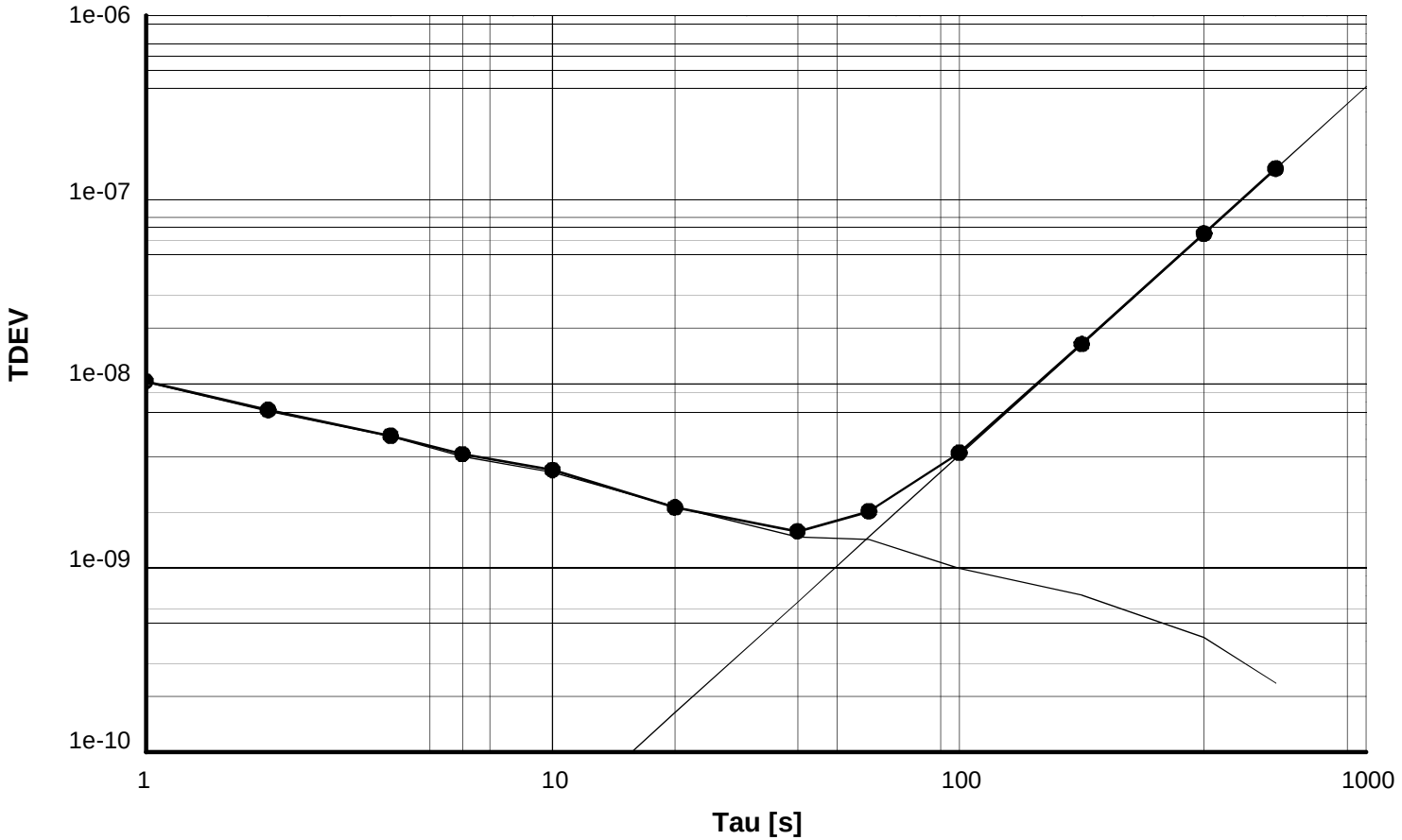


Figure 12-42 : White Phase Modulation + Frequency Drift 8.64e-8/day (TDEV)

12.5.42 White Phase Modulation + Frequency Drift 8.64e-8/day (ADEV)

Measurement: 2000 x 1 second(s)
Comments: simulated

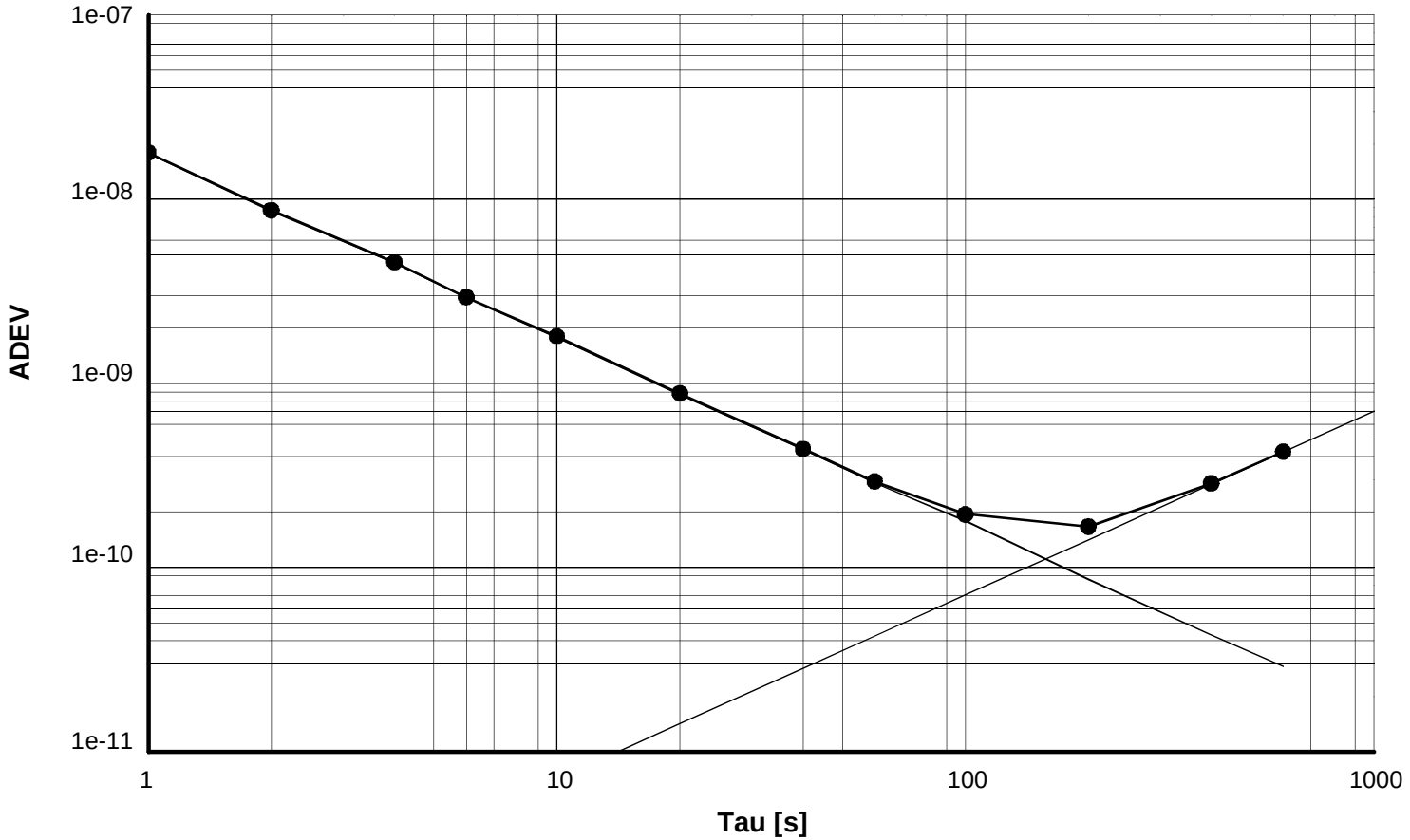


Figure 12-43 : White Phase Modulation + Frequency Drift 8.64e-8/day (ADEV)

12.5.43 White Phase Modulation + Phase Modulation 1e-8 sin (pi*t/100) (TIE)

Measurement: 2000 x 1 second(s)
Comments: simulated

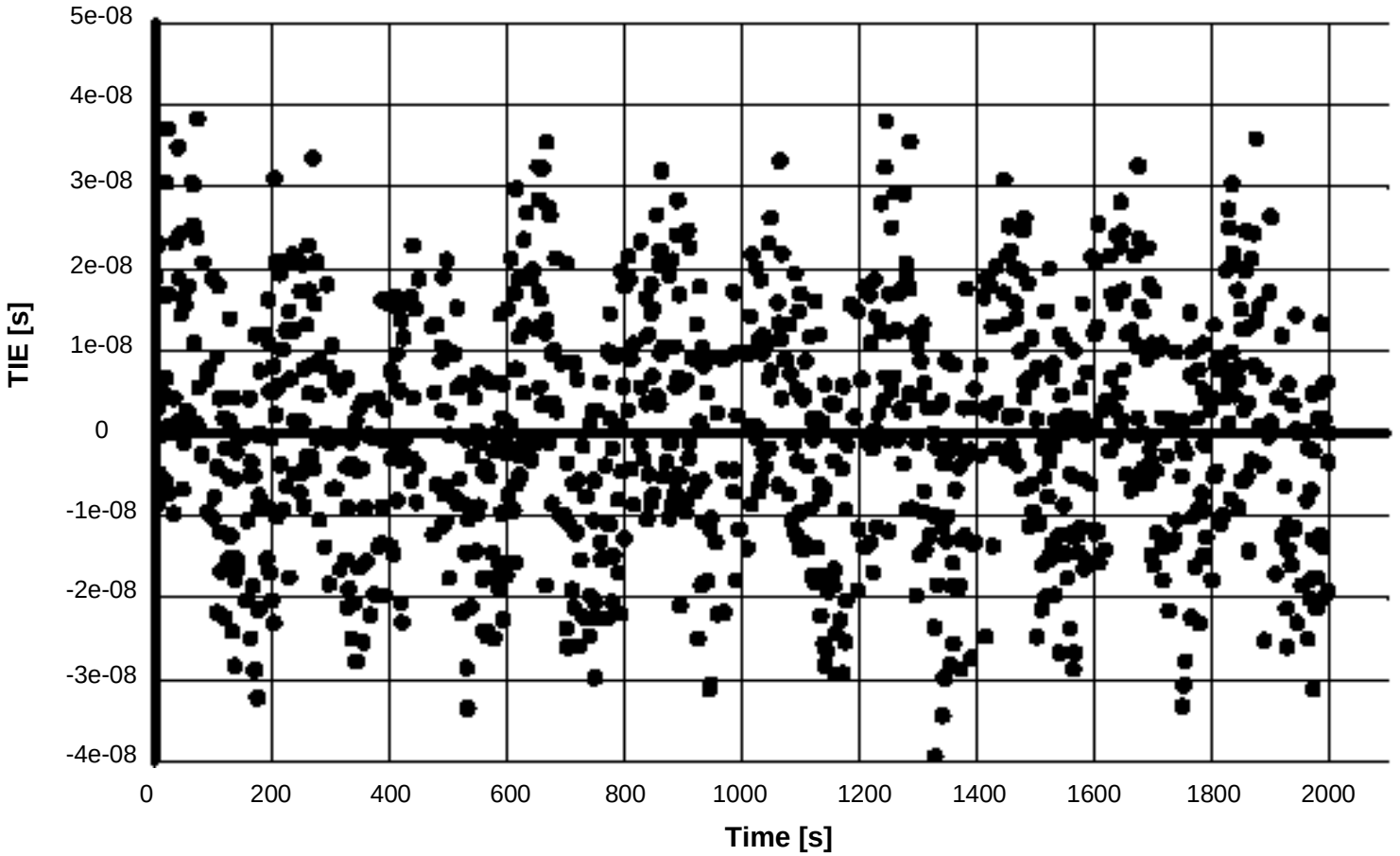


Figure 12-44 : White Phase Modulation + Phase Modulation 1e-8sin(pi*t/100) (TIE)

12.5.44 White Phase Modulation + Phase Modulation 1e-8 sin (pi*t/100) (MTIE)

Measurement: 2000 x 1 second(s)
Comments: simulated

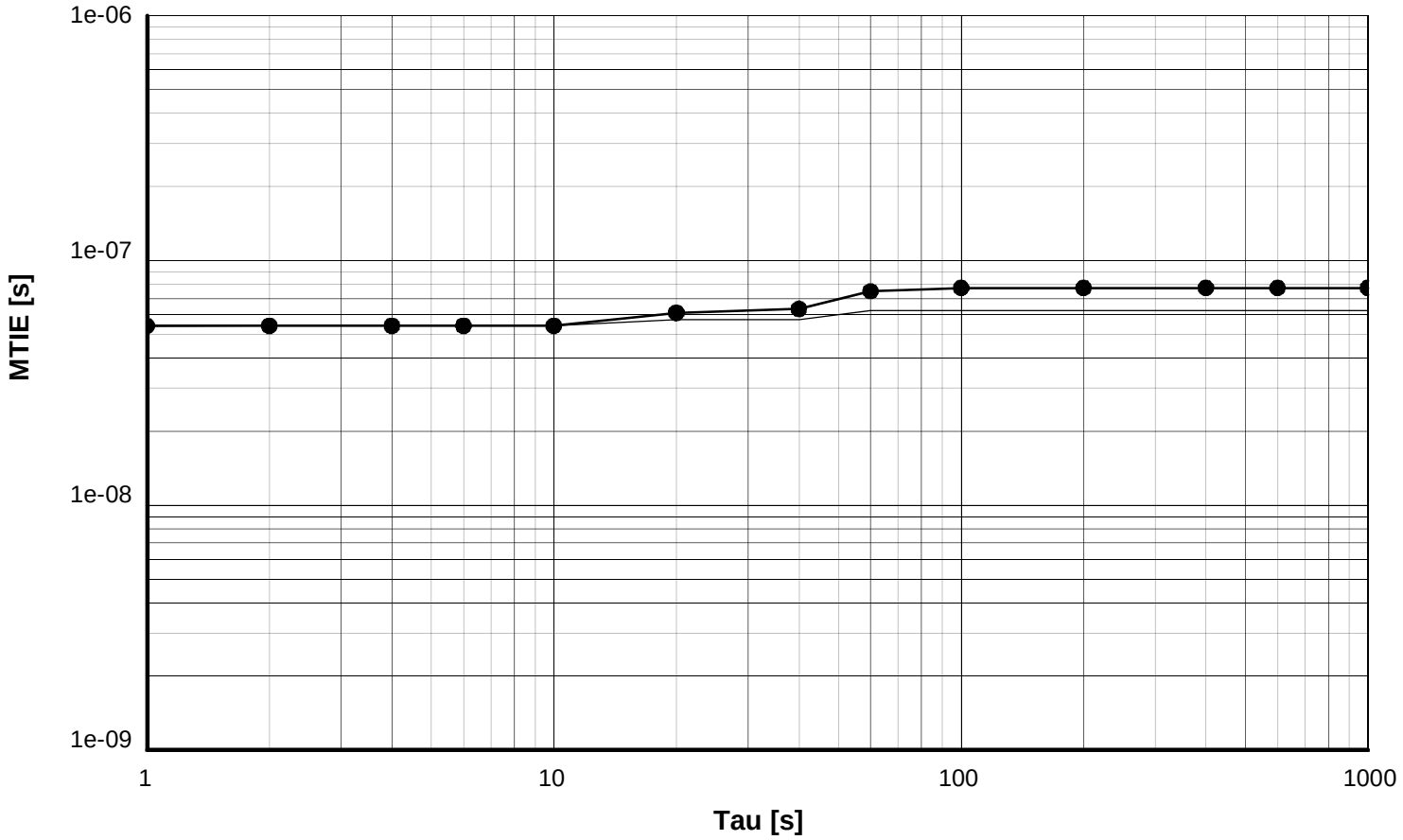


Figure 12-45 : White Phase Modulation + Phase Modulation 1e-8sin(pi*t/100) (MTIE)

12.5.45 White Phase Modulation + Phase Modulation 1e-8 sin (pi*t/100) (MADEV)

Measurement: 2000 x 1 second(s)
Comments: simulated

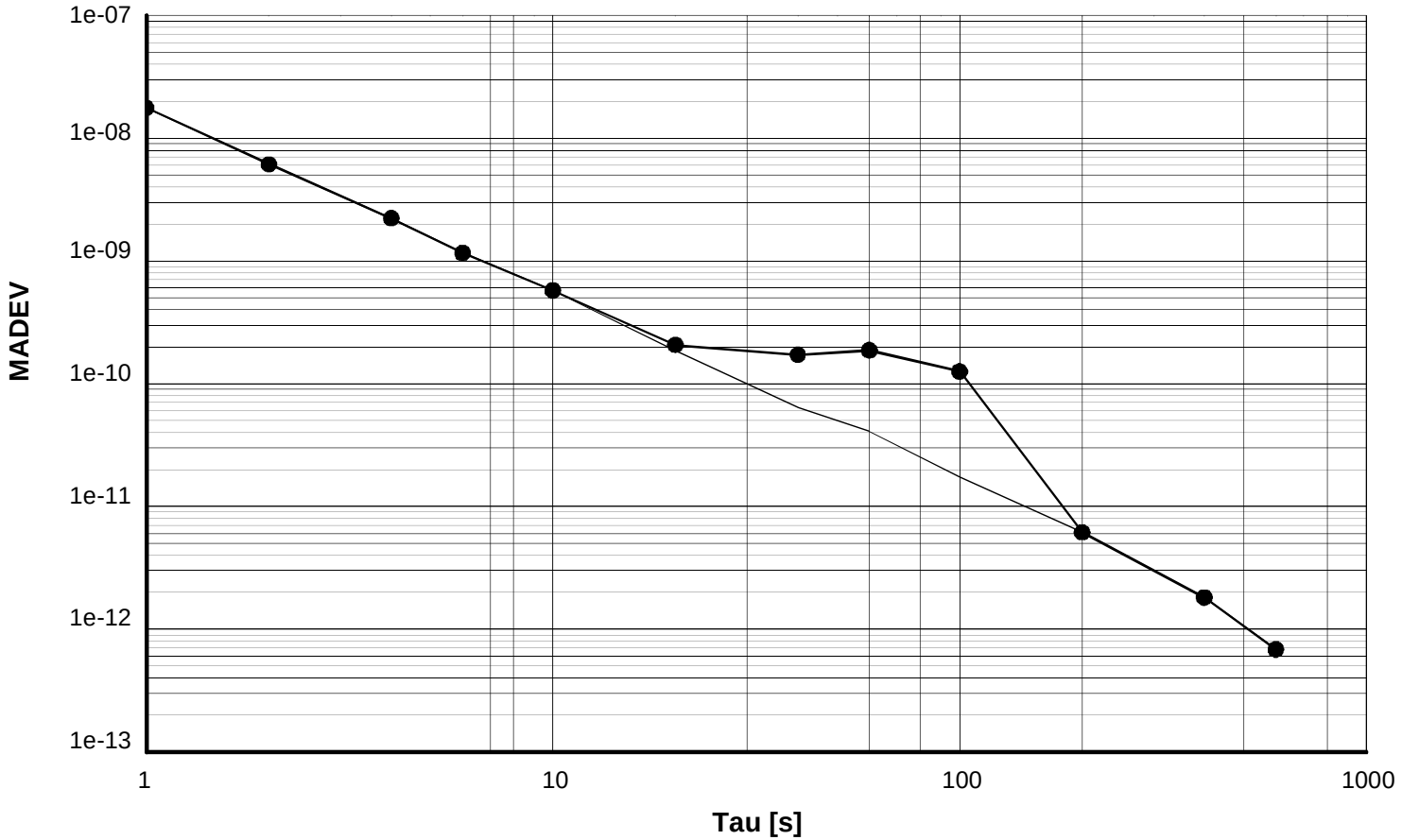


Figure 12-46 : White Phase Modulation + Phase Modulation 1e-8sin(pi*t/100) (MADEV)

12.5.46 White Phase Modulation + Phase Modulation 1e-8 sin (pi*t/100) (TDEV)

Measurement: 2000 x 1 second(s)
Comments: simulated

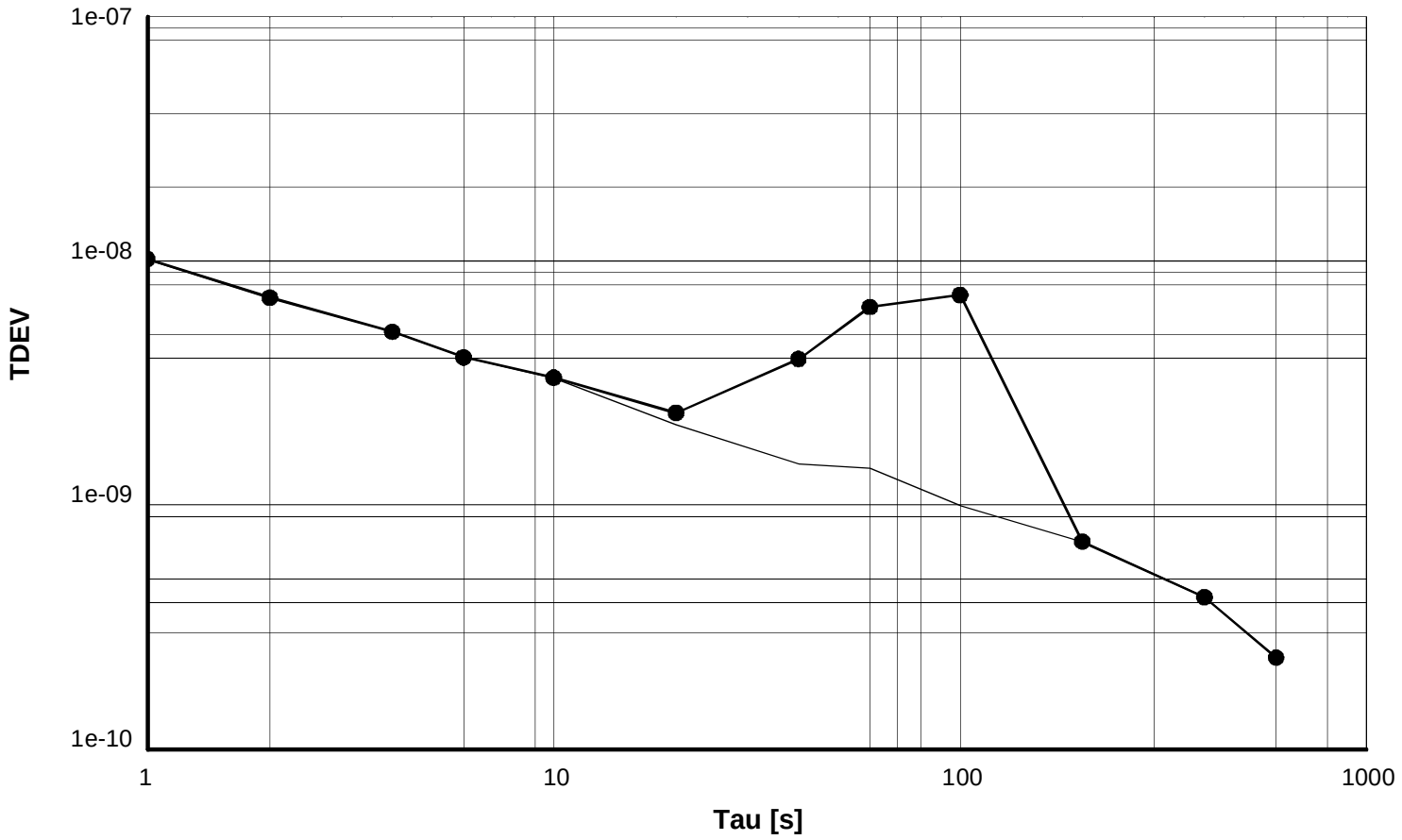


Figure 12-47 : White Phase Modulation + Phase Modulation 1e-8sin(pi*t/100) (TDEV)

12.5.47 White Phase Modulation + Phase Modulation 1e-8 sin (pi*t/100) (ADEV)

Measurement: 2000 x 1 second(s)
Comments: simulated

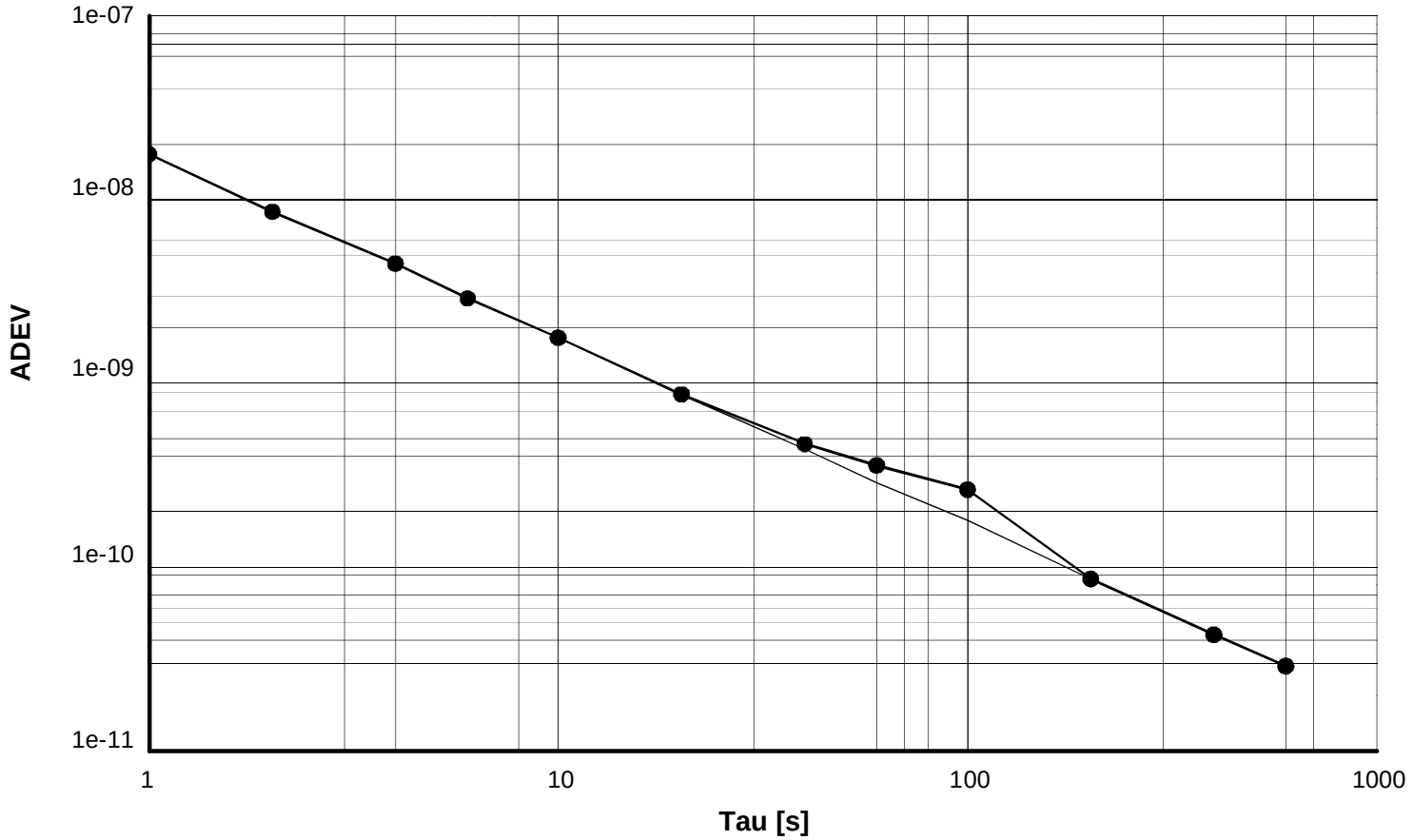


Figure 12-48 : White Phase Modulation + Phase Modulation 1e-8sin(pi*t/100) (ADEV)

12.5.48 White Phase Modulation + Phase Modulation 1e-8 sin (pi*t/64) (TIE)

Measurement: 2000 x 1 second(s)
Comments: simulated

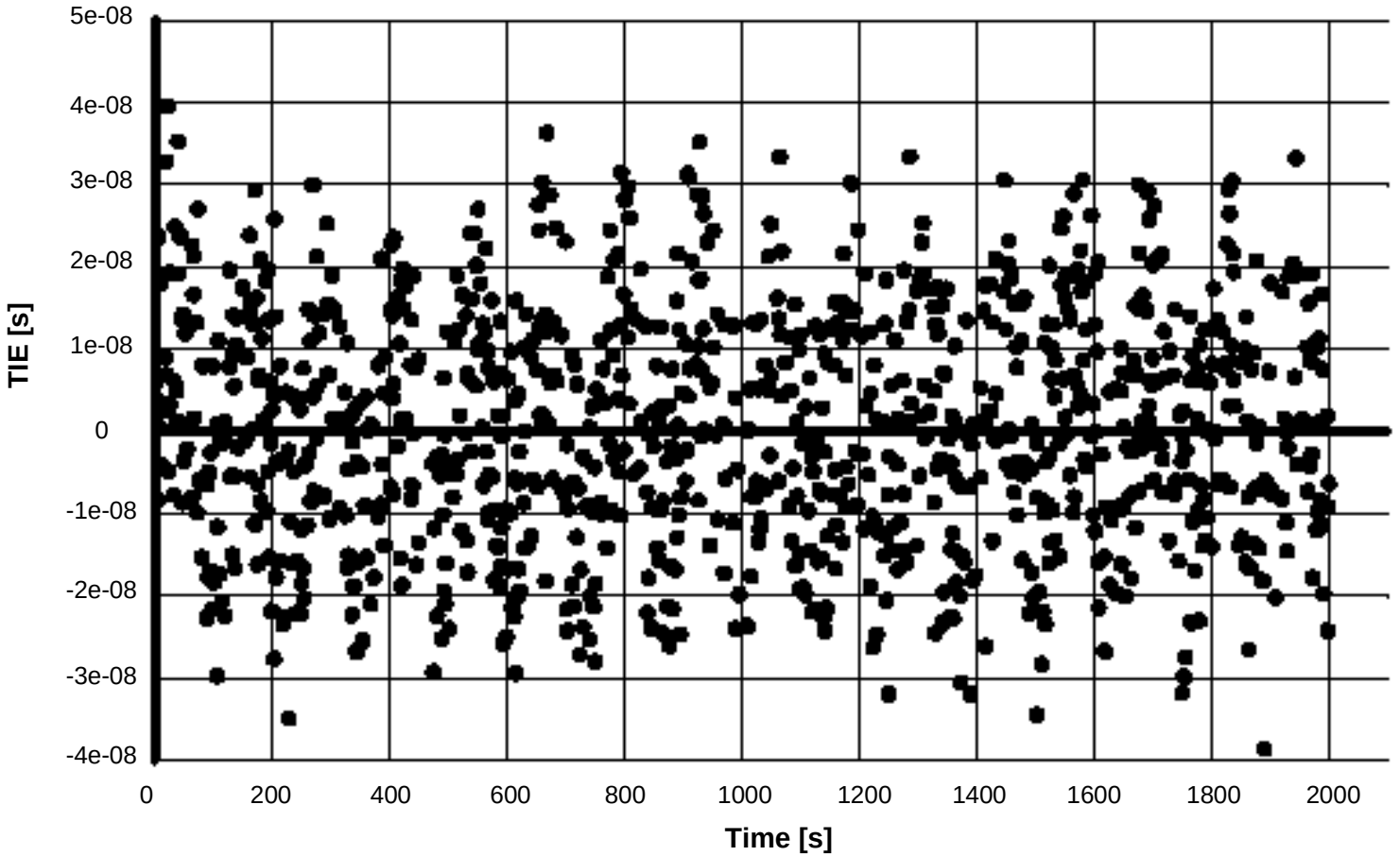


Figure 12-49 : White Phase Modulation + Phase Modulation 1e-8sin(pi*t/64) (TIE)

12.5.49 White Phase Modulation + Phase Modulation 1e-8 sin (pi*t/64) (MTIE)

Measurement: 2000 x 1 second(s)
Comments: simulated

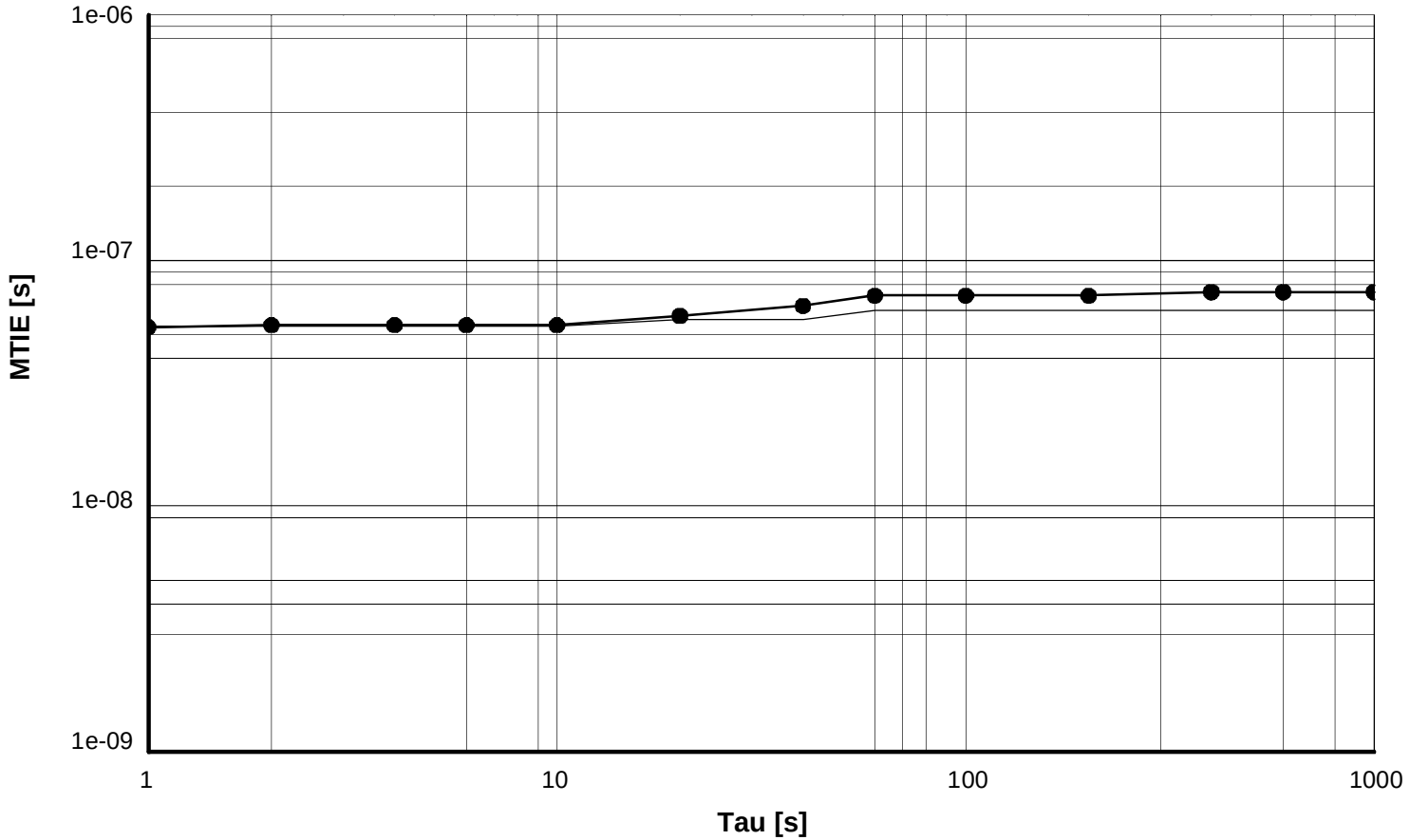


Figure 12-50 : White Phase Modulation + Phase Modulation 1e-8sin(pi*t/64) (MTIE)

12.5.50 White Phase Modulation + Phase Modulation 1e-8 sin (pi*t/64) (MADEV)

Measurement: 2000 x 1 second(s)
Comments: simulated

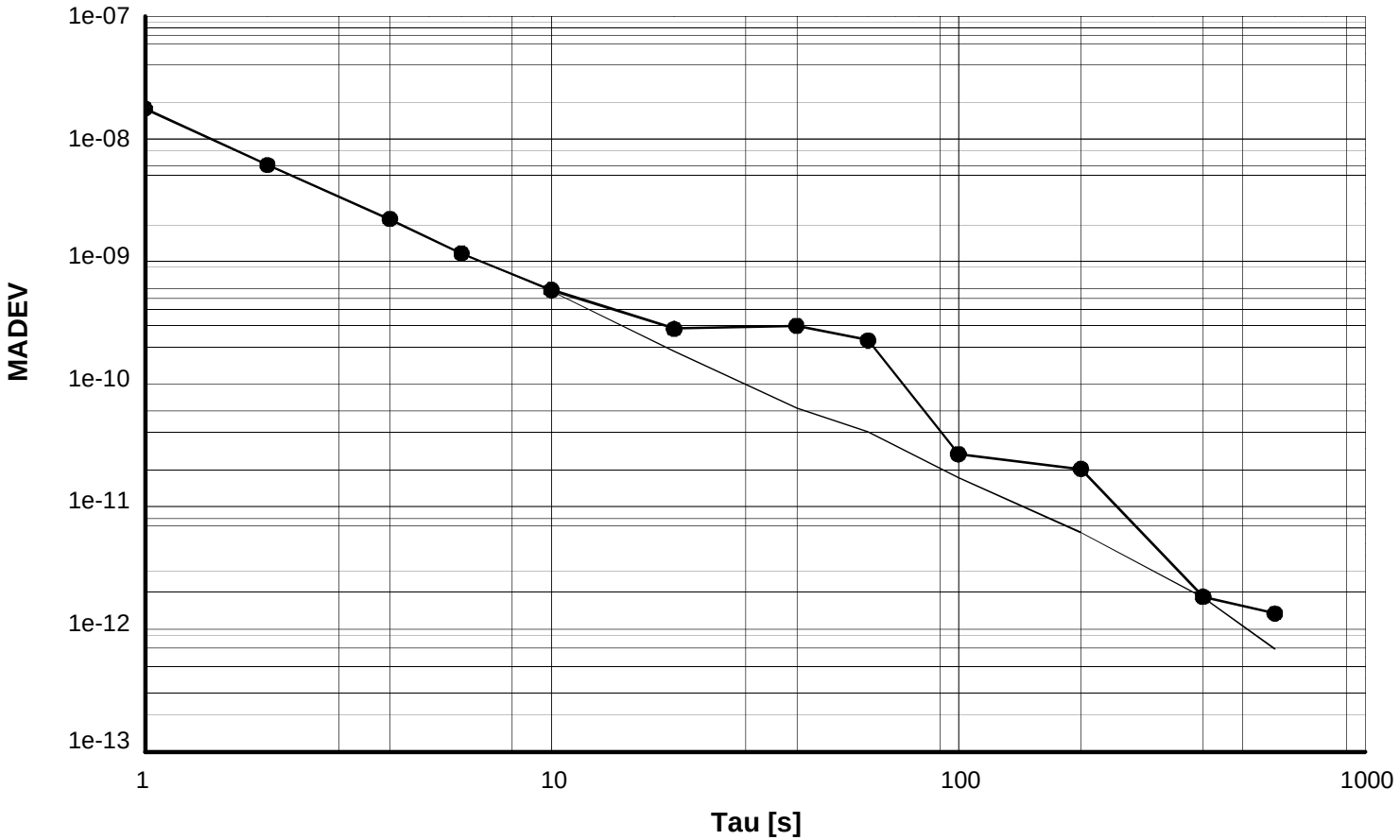


Figure 12-51 : White Phase Modulation + Phase Modulation 1e-8sin(pi*t/64) (MADEV)

12.5.51 White Phase Modulation + Phase Modulation 1e-8 sin (pi*t/64) (TDEV)

Measurement: 2000 x 1 second(s)
Comments: simulated

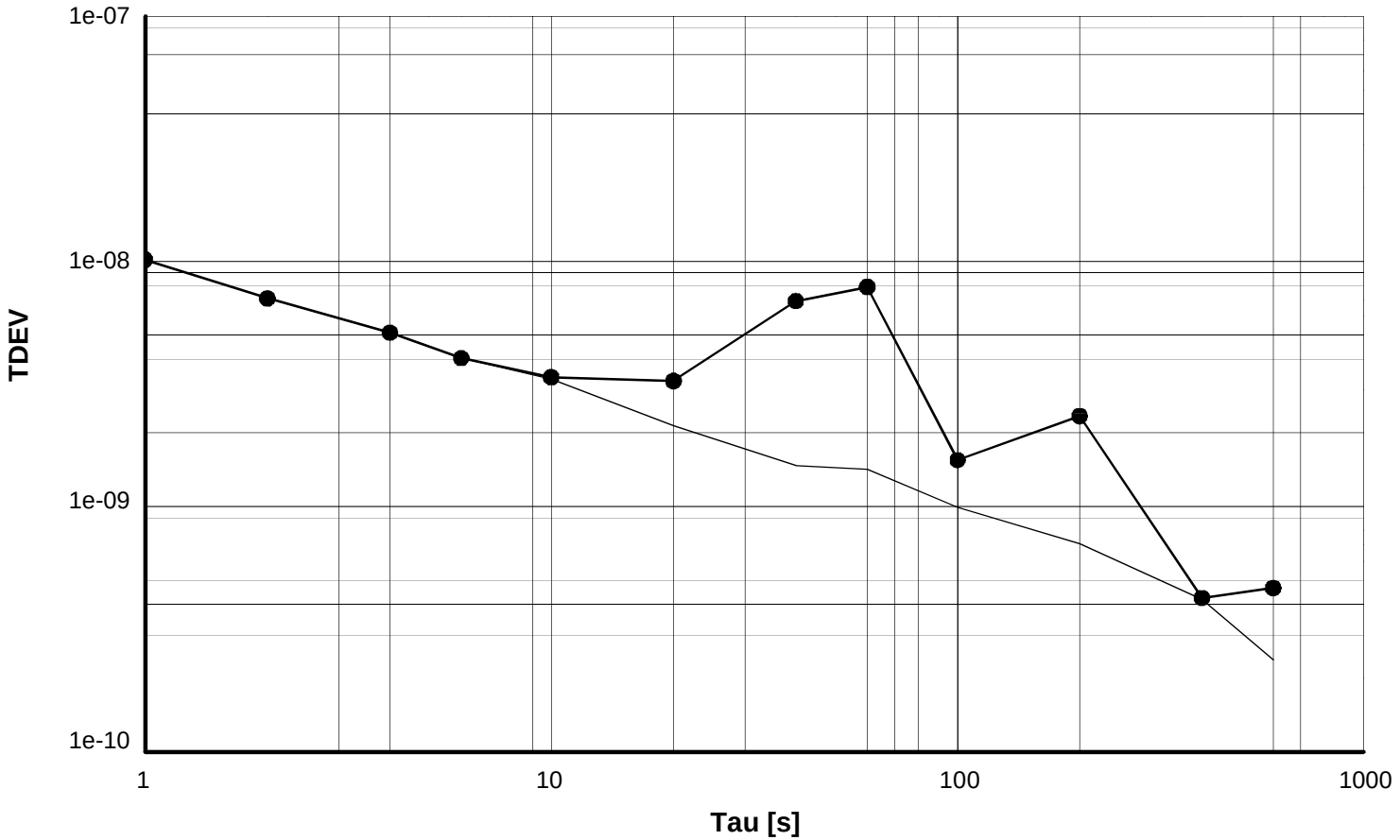


Figure 12-52 : White Phase Modulation + Phase Modulation 1e-8sin(pi*t/64) (TDEV)

12.5.52 White Phase Modulation + Phase Modulation 1e-8 sin (pi*t/64) (ADEV)

Measurement: 2000 x 1 second(s)
Comments: simulated

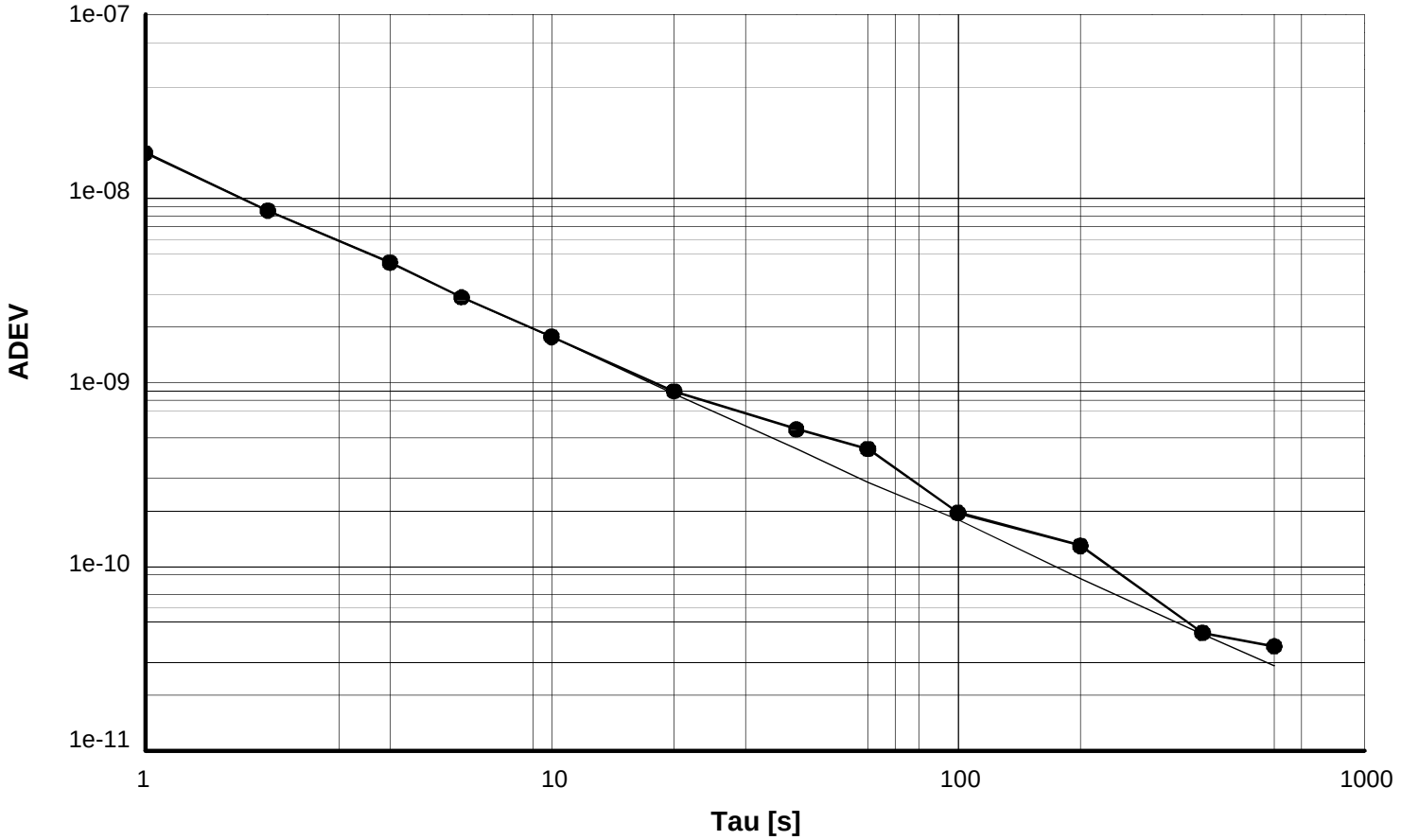


Figure 12-53 : White Phase Modulation + Phase Modulation 1e-8sin(pi*t/64) (ADEV)

Appendix A:

Ordering Information

The following tables contain the article and drawing numbers for ordering spare and replacement components, as well as accessories for the OSA 5565 STS. Please use both numbers and description when placing your order. To contact Oscilloquartz, refer to **section 9.3**

Cards

Comp.	Description	Article number	Drawing number
IIU-2/M ESF	Input Interface 1.544 Mbit/s B8ZS/ESF	A014298	942.085.066
IIU-2/M D4	Input Interface 1.544 Mbit/s AMI/D4(SF)	A014299	942.085.066
IIU-6/M	Input Interface 2.048 Mbit/s HDB3/CAS	A013417	942.085.068
IIU-10/M	Input Interface 2.048 MHz	A013420	942.085.075.01
Rb INT	Rubidium Interface	A011232	942.085.030
PMU	Phase Measurement Module	A006013	942.085.330
Freq Conv.	Frequency Converter	A006088	942.085.946.50
MAC	Alarm Card	A006025	942.085.516.01

Table 12-5 Ordering Cards

Accessories & Options

Topic	Description	Article number	Drawing number
DOC	User Manual & WinSTS on CD-ROM	A012341	DOC.556.500
	User Manual - Printed Version	A012680	990.512.301
Accessory Kit	For AC Power Supply	A011548	942.089.907
Carrying Bag	Safe travelling bag for transporting STS	A011350	981.803.420

Table 12-6 Ordering Accessories & Options

This page has been intentionally left blank

Document History

Project N°	:	5565-xx
Document Type	:	User Manual
Version	:	English
Author	:	OSA/MUTH
Revision	:	A
Last Up-date	:	25.04.2010
Creation	:	25.04.2010

REVISION	DATE	CORRECTIONS
A	25.04.2010	- Creation based on WinSTS 2.2x